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PARTIAL-CUTTING SAFETY HANDBOOK

July 1997

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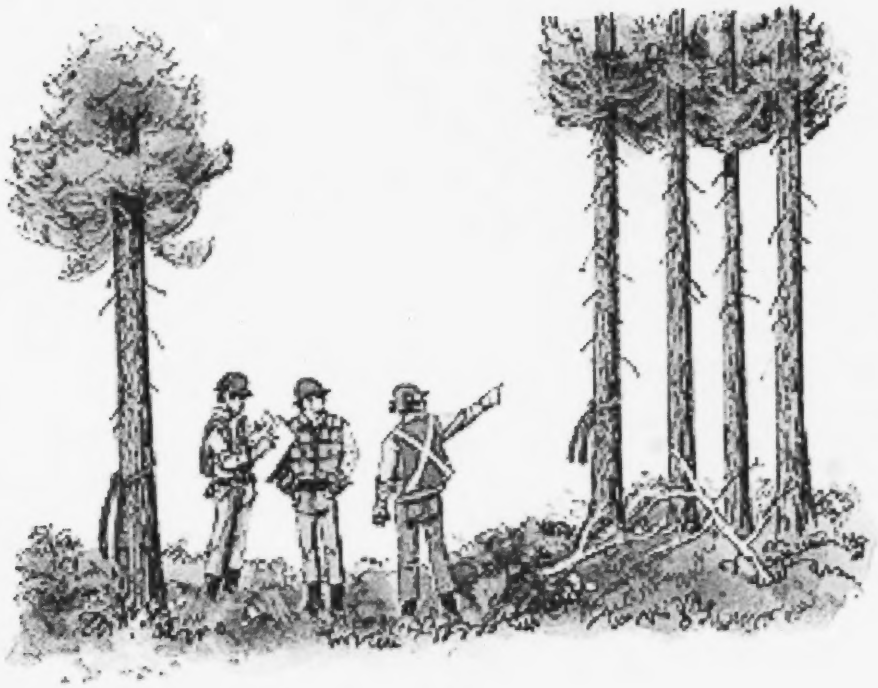
SAFETY HANDBOOK



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Forest Practices Branch
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Preface

The need to manage forests effectively for a wide variety of uses will undoubtedly lead to an increase in the application of partial-cutting systems across the province. Increasing the area harvested through partial cutting will require significantly more pre-harvest planning, design and engineering of harvesting operations. It will also require increased levels of forest worker retraining to acquire the advanced skills and knowledge needed to implement partial-cutting systems in the field.

As this process unfolds, issues and concerns regarding worker safety have emerged. This Partial-cutting Safety Handbook has been developed to address these safety issues.

An initial project to evaluate potential safety risks associated with partial cutting in British Columbia was initiated in 1994 by the Ministry of Forests, in cooperation with the Workers' Compensation Board. The project sought to describe potential hazards, identify safety concerns, and develop recommendations to minimize work hazards.

Several of the recommendations from the project identified the need for a handbook to describe and address these hazards. This handbook is intended for workers, logging supervisors and forest planners involved in partial-cutting operations. A project team of Ministry of Forests, Ministry of Environment, Lands and Parks, and Workers' Compensation Board members was established in 1995 to guide the development of this project.

The material presented may be used to plan and implement safe partial-cutting operations. It is not intended to replace, but rather to supplement, existing (WCB) handbooks and standards.

Acknowledgements

Many individuals have contributed their time and expertise to the development of this handbook. Special thanks are extended to those persons from around the province who provided such thorough review of the various draft versions. In particular, we would like to thank the following people for their input and support: Peter Bradford and Janet Agnew (Ministry of Forests, Forest Practices Branch); Stewart Guy (BC Environment, Resource Stewardship Branch); David Rowe, Cary White and Lorne Pelto (Workers' Compensation Board); Dean McGeough (Integra Forest Consulting); Allan Lundgren (TimberWest Forest Ltd.); Bill Golding (Silvicon Services); Fred Marshall (Marshall Forestry Services); Terry Gordon (Sylvan Forestry) and Jim Allman (previously with Ministry of Forests).

The final version of the handbook and accompanying field cards were prepared by Nick Baggs (N.G.B. Forest Management Consulting) and Todd Manning (Branta Consultants). Illustrations were provided by George McLachlan. Field card design and layout were provided by Soren Henrich. Sheilagh Ogilvie did the layout and design of the handbook. Bill I'Anson did the English editing.

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Purpose of This Handbook

This handbook of safety guidelines for partial-cutting operations was produced cooperatively by the BC Forest Service, Ministry of Environment, Lands and Parks, and the Workers' Compensation Board of BC, at the request of industry, labour and other interested agencies.

The handbook does not replace WCB Regulations; rather, it supplements them by providing examples of safe work procedures to follow when partial cutting. Complying with WCB Regulations, following general safety regulations while harvesting (see the list of references), and applying the guidelines in this handbook will reduce harm and injury to forest workers.

It has been designed for use by planners, logging supervisors and forest workers involved in partial-cutting operations. While there are differences between coastal and interior operations—terrain, timber size, weather conditions, etc.—these basic safe work procedures apply to the entire province.

How to Use This Handbook

This handbook covers the implementation of partial-cut logging methods through all phases of planning and operations. Starting with general considerations given to partial cutting in the forest development plan, the handbook introduces progressively more detailed planning concepts for partial cutting, from initial layout and design, through to the development of silviculture prescriptions. Finally, the handbook outlines safe operating procedures and checklists for conducting actual harvest operations.

It has been divided into two main sections. The first section, *Planning for Safety in Partial Cuttings*, proposes safe guidelines for *planning* partial-cutting silvicultural systems. The second section, *Working Safely in Partial Cuttings*, offers safety guidelines for *carrying out* partial-cutting operations.

Safe planning guidelines and work procedures for felling, cable, helicopter, ground-based and horse-logging operations are outlined in this handbook.

For purposes of this handbook:

- *Planners* include those individuals responsible for all phases of plan development, including initial layout and design, forest development plans, and silviculture prescriptions (e.g., strategic planners, foresters and technicians).
- *Logging supervisors* include those individuals (e.g., the landowner, logging contractor, licence holder, or their designate) who are responsible for supervising logging operations.
- *Workers* include those individuals (e.g., fallers, yarding and hill crews, machine operators, teamsters and climbers) who actually carry out harvesting activities.

Although planners may wish to read only the first section of the handbook, they should also read the second section to gain a better appreciation of the operational details that must be considered by workers implementing their plans.

Logging supervisors should read both the first and second sections to help them integrate planning objectives with the management and supervision of daily logging operations.

Workers may choose to read only the second section dealing with operations, but are advised to also read the first section to better understand the planning process and management objectives.

It is the responsibility of all participants to acquire a working knowledge and understanding of each other's job responsibilities, concerns, and work hazards, as well as the legal requirements for ensuring safe implementation of partial-cut logging methods.

Introduction

As public expectation grows for the consideration and protection of non-timber values such as wildlife habitat, water quality, soil conservation, biodiversity, recreation, aesthetics and cultural heritage, smaller clearcuts and partial cuttings are being employed more and more frequently in B.C. logging operations. Maintenance of environmental integrity, economically sustainable development and forest regeneration must all be achieved by the wise application of appropriate silvicultural systems across the forested landscape.

The *Forest Practices Code of British Columbia Act* requires that all silvicultural systems be considered in harvest planning, and that partial cutting be used in specific areas where the protection of wildlife habitat, water quality or other resource values require the maintenance of a partial forest canopy. Partial cutting is a general term for silvicultural systems in which some trees are left standing after logging.

These trees are retained to provide forest structure and wildlife habitat requirements necessary to meet the social, cultural and environmental demands placed on our forests.

Individual leave-trees distributed across the cutblock are intended to provide seed or shelter for the regeneration of the site, while undisturbed reserves or wildlife tree patches are most often intended to protect:

- watershed and riparian areas (rivers, streams, lakes, wetlands, gullies);
- biodiversity (fisheries, nest and den sites, wildlife trees, rare and endangered plants and animals);
- visual quality or scenic values/resources;
- recreation;
- sensitive areas (unstable soils, steep terrain, rock outcrops, windthrow-prone areas);
- cultural heritage (archaeological sites, trails, culturally-modified trees, and other examples of historic use).

The main operational difference between clearcutting and partial cutting is that partial cutting leaves varying numbers of trees on site following harvest. Therefore, workers are exposed to the hazards and risks associated with felling and yarding under a partial canopy or near reserves.

Silvicultural Systems

In British Columbia there are four different silvicultural systems in use:

Clearcutting: the removal of all trees from an area in a single harvest entry. Patch cutting is a form of clearcutting, where small openings less than one hectare in size are created. Clearcutting with reserves is a form of partial cutting where some trees are left within the cutblock to provide wildlife habitat and aesthetic value.

Shelterwood: a form of partial cutting which involves the removal of trees in a series of harvests to establish a new even-aged crop under the shelter of older trees. The shelter trees may also provide a source of seed for the next generation. Shelter trees may eventually be harvested or left to help provide biological diversity, wildlife habitat and aesthetic value.

Seed Tree: a form of partial cutting which involves leaving selected trees standing in the cutblock, either individually or in small groups, to provide natural regeneration for a new even-aged stand. The largest and healthiest trees are left to provide high quality seed for the next generation. The seed trees may be harvested after regeneration or left to provide structural diversity, wildlife habitat and aesthetic value.

Selection: a form of partial cutting which involves maintaining or achieving a continuous uneven-aged forest by harvesting a limited number of trees, of various ages and sizes, over intervals of 5 to 40 years either in small groups (group selection) or individually (single tree selection). Regeneration occurs in the gaps created by logging.

Intermediate Cuts

Intermediate cuts are another form of partial cutting for the purpose of commercial thinning or pole removal. They are done as a single-entry in stands which contain merchantable timber.

Safety in Partial Cuttings

Safety risks in partial cuttings can be reduced long before work begins by:

- adequate advance planning, beginning with the forest development plan, through to the development of the silviculture prescription;
- initial layout and design that takes site-specific hazards into account, and considers equipment limitations;
- designating an experienced individual to make decisions regarding changes to standard operating procedures or to deal with extraordinary events: this "person in charge" should be familiar with the type of partial cutting being practiced;
- flexible leave-tree options that allow fallers to make use of their experience and knowledge of the site to compensate for hazards and felling difficulties present within the stand;
- ensuring workers know their duties and responsibilities and how to do the job.

Planners responsible for the design of partial-cutting systems require training and experience in harvesting methods and operational safety. Foresters must be trained to a level that will enable them to develop practical, safe silviculture prescriptions that meet the specific objectives for the land base.

Workers in partial-cutting operations are often responsible for a wide variety of job functions and will almost certainly need additional training or upgrading to meet the requirements of the work. Training should aim to improve skills and knowledge related to:

- operational sequences for different cutting patterns;
- machine operation for new harvesting methods;
- felling in partial cutting;
- partial cutting on potentially unstable slopes and near riparian reserves/wildlife tree patches;
- assessment of wildlife/danger trees;
- windthrow hazard assessment;
- map reading and interpretation.

Risks and Responsibilities

Risk is associated with the implementation of any logging method or silvicultural system. However, those involved with partial cutting face additional risks and must therefore promote and maintain special safe-work practices.

- Managers must take responsibility for safety in overall planning, production and economy of the operation.
- Supervisors must take responsibility to ensure safe procedures are followed during all phases of the logging operation.
- Workers must take responsibility for their own safety, and for the safety of their fellow workers.

Unsafe work procedures must be identified and corrected. If safety concerns cannot be resolved among workers, the supervisor must be notified immediately to help resolve concerns. As workers have to make many routine decisions throughout the work day without direct supervision, understanding one's responsibilities and following safe work procedures will minimize exposure to danger and the risk of injury.

Section One

Planning for Safety in Partial Cuttings

Safety in the Operational Planning Phases

This section recommends safety guidelines for partial cutting in each of the planning phases—the forest development plan, initial layout and design, and the silviculture prescription. General safety concerns for each planning phase are followed by safety guidelines specific to felling, cable, helicopter, ground-based, and horse-logging operations.

Planners are responsible for the identification of hazards unique to the partial-cutting system selected in each of the planning phases. They must implement measures and safe operating procedures which ensure that worker safety is adequately considered in both logging and silviculture.

Guiding principles for partial cutting should be built upon standard operating procedures used for conventional harvest methods in order to minimize hazards and optimize worker safety. Planners must be knowledgeable of measures to minimize harvesting risk. Forest workers need to have an understanding of the silvicultural system and its goals. Worker safety requires the integration of management objectives and harvesting activities, both in the office and in the field.

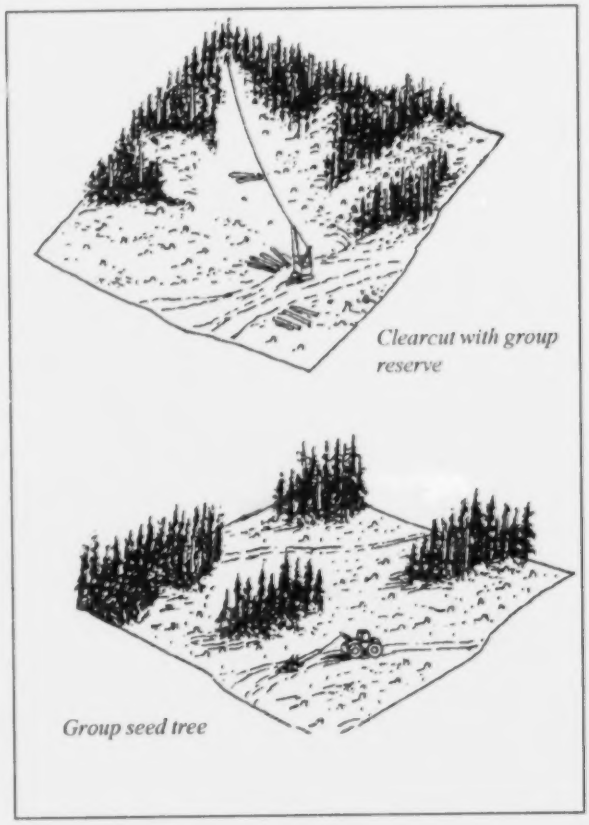
Planners are often hampered by a lack of detailed knowledge or familiarity with site conditions for the area under consideration. Consequently, planners should avoid setting overly restrictive operating criteria and place increased emphasis on communicating management objectives to supervisors and workers. In this way, individuals who are actually carrying out the logging may apply their knowledge and expertise to meet the stated management objectives safely and efficiently.

Involve fallers and other forest workers in the decision-making process, to ensure safe harvesting operations.

Phase I: Forest Development Plan

The forest development plan describes and illustrates where harvesting and road development for a specific area will be undertaken for a period of at least five years. In this broad-based plan, safety and partial cutting are considered at a nonspecific landscape level: for example, safe operating procedures for steep slopes, burns and difficult terrain may determine which harvest methods and silvicultural systems are most appropriate for certain cutblocks.

- Planners preparing the forest development plan should:
  - ~ review any landscape-level management objectives identified in higher-level plans and identify the range of silvicultural systems that might be applied under different stand and site conditions to meet those objectives
  - ~ identify probable or known locations of hazardous/problem/special resource areas (e.g., unstable class IV and V slopes, landslide and blowdown events, avalanche tracks, wind-exposed areas, floodplains, old-growth management areas, wildlife habitat areas or other significant wildlife/recreational/cultural features
  - ~ consider traditional weather patterns (e.g., wind direction, seasonal storm events) and operating restrictions
  - ~ propose mitigative measures where operations may impact identified values and other resource uses.

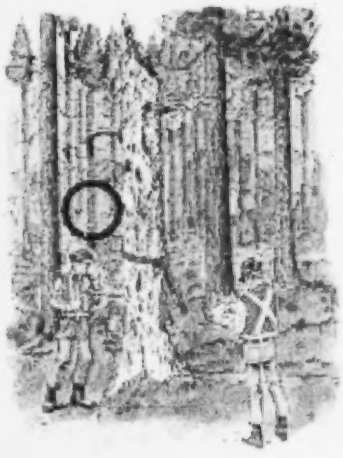


Choose a silvicultural system to meet landscape-level management objectives identified in higher-level plans.

Phase II: Initial Layout and Design

In the layout and design stage, the planner clearly marks out the operating area within the cutblock. At this stage, the planner is identifying or confirming the presence of site hazards, critical stand characteristics, safety concerns and resource values that may influence the choice of silvicultural system. This information should be considered within the context of both landscape- and stand-level objectives identified in the forest development plan, and will be instrumental in the development of the silviculture prescription and actual operations. Final layout will be modified by the planners to ensure both feasibility and worker safety.

- Planners must consider worker safety as it relates to:
  - felling patterns and techniques
  - yarding/skidding methods
  - equipment access limitations/operability
  - ground stability: risk of rock and mud slides
  - riparian reserve and management zones, and no-machine zones
  - danger tree removal
  - wildlife tree patch retention
  - wind exposure hazards and windfirm stand characteristics
  - snow slide hazards
  - fire protection
  - emergency evacuation and first-aid requirements.
- Planners should ensure that boundaries, access trails and riparian management zones/ reserves are clearly marked to orient fallers and machine operators within the cutblock.
- Planners should consider and note the location of anticipated emergency evacuation routes.
- Planners should ensure that first-aid procedures and equipment can be adequately located on site.



Any wildlife tree that potentially impacts the work area must be assessed by a qualified wildlife/danger tree assessor to be considered for retention.

No-Work Zones and Wildlife/Danger Trees

A no-work zone (NWZ) is a zone created to prevent workers from entering areas made hazardous by the presence of danger trees or other hazards.

- No-work zones are normally delineated by ribbons at the initial planning stage. In silviculture or other low-impact activities, ribbons alone are acceptable for the duration of the project. In construction and timber harvesting, the no-work zone must be enhanced by selecting and marking sound green trees that are not to be felled.
- No workers other than fallers or assessors may enter no-work zones at any time. Fallers may enter no-work zones to eliminate hazards, but must leave any trees felled for safety reasons on site, unless approved for removal by the Forest Officer. All workers must stay clear of no-work zones with standing timber during periods of high wind.

Any wildlife tree that potentially impacts the work area must be evaluated by a qualified wildlife/danger tree assessor before it can be designated for retention within a wildlife tree patch (WTP) or no-work zone along the cutblock boundary. This must occur in conjunction with initial block layout, to ensure that the location of no-work zones and wildlife tree patches does not compromise the felling plan.

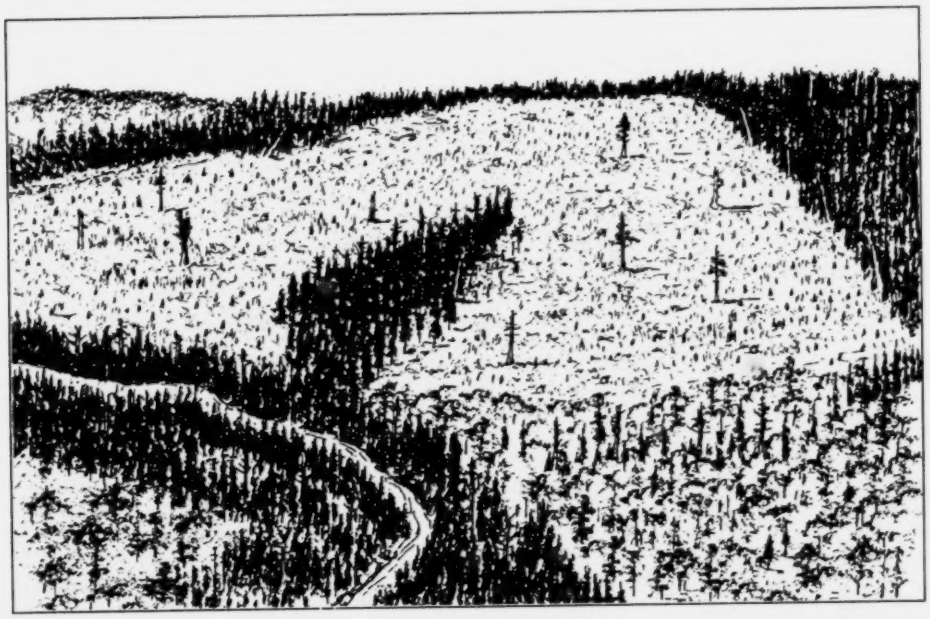
Phase III: Silviculture Prescription

The silviculture prescription is a site-specific plan which describes the harvesting method, reforestation and stand tending activities required to meet the legal and contractual obligations of the licence holder to regenerate a free-growing stand of trees. It must be consistent with the provisions of the forest development plan, but flexible enough to allow for the implementation of the proposed silvicultural system under the range of site and stand conditions likely to be encountered. At this stage, it is essential that planners identify and understand potential work hazards and the actions which can be taken to minimize or eliminate them.

- With the increased complexity of planning for partial cutting and the retention of leave-trees and reserves under different silvicultural systems, planners should call on the expertise of operations personnel for input on layout, reserve area locations, yarding corridors, and leave-tree selection.
- Planners should identify and map:
  - the location of potential hazards or problem areas (e.g., shallow soils, steep slopes, high water seepage areas)
  - critical site factors that may affect worker safety using the stated silvicultural systems and harvest methods (e.g., slope stability, windfirmness of a stand)
  - the location of danger trees having high value for wildlife, which may be designated for retention within a wildlife tree patch or an appropriate no-work zone along the cutblock boundary to meet specific stand-level biodiversity/wildlife objectives stated in the forest development plan.
- Planners must recognize that damage and hazards created during partial cutting (e.g., cut roots and stem damage, widowmakers) may persist until the next harvest entry or planned forest activity (e.g., planting, spacing, brushing), and should therefore plan for future assessment and hazard mitigation.
- In selecting the silvicultural system and harvesting method, planners must consider the following:
  - landscape- and/or stand-level objectives identified in the forest development plan
  - traditional weather patterns (e.g., prevailing wind direction and seasonal storm events)
  - hydrological impact on soil stability
  - ground slope, soil type, rooting depth and moisture regime as they relate to windfirmness
  - stand density, structure and species composition
  - tree species for removal and retention, rooting habit, and crown form as they relate to windfirmness
  - indicators of poor tree health (e.g., root rot; mistletoe; beetle infestations; damaged/defoliated trees; stem, crown and root deterioration)

- ~ hydrological and soil disturbance impacts on root disease initiation
- ~ wildlife tree requirements—patch and dispersed
- ~ number and distribution of danger trees
- ~ production levels and maintenance of safety performance standards
- ~ availability of trained and experienced staff.

- For intermediate cuts, good site layout is essential, and planners must consider special safety issues created by:
  - ~ high stem densities
  - ~ frequent small-diameter snags
  - ~ worker-level branch hazards
  - ~ obstacles and remnants of the previous harvest, such as dead-top vets, springboard stumps, large remnant logs, snags and previously damaged trees.



Wildlife tree patch.

Wildlife Tree Patches

When determining the best location for wildlife tree patches, try to incorporate as many of the following desirable characteristics:

- abundance of high quality wildlife trees
- mix of live and dead trees (decay classes 2–6)
- range of large and small stems; some stems should be in the upper 10% of the diameter range distribution for the site
- coarse woody debris (range of decay classes and piece sizes)
- evidence of wildlife tree use (nesting, denning and feeding)
- deciduous component (trees and shrubs) where present
- live deciduous trees that have external fungal conks or cankers
- representative stand densities
- windfirm stand characteristics
- closeness to, or including riparian habitat, streams, wetlands, gullies, ravines, rock outcrop complexes, and meadows
- maintenance of intact forest floor structure, and protection of sensitive soils, seepage areas, unstable slopes
- areas already constrained from logging (e.g., riparian reserves, inoperable terrain, steep slopes and sensitive soils.

> *It is especially difficult to plan for the retention of wildlife trees where uniform distribution of residual trees is the objective under a seed tree, shelterwood, single-tree selection or clearcut with reserves silvicultural system. The overlapping no-work zones of even a small number of designated wildlife trees may necessitate leaving group reserves rather than uniformly distributed leave-trees.*

Safety Planning in Harvest Operations

General Safety Considerations During Harvest Operations

Prior to actual logging operations, it is essential that planners identify and understand potential hazards, and prescribe the actions necessary to minimize or eliminate them. All operations must be planned to ensure worker safety.

Efficient layout and corridor design are essential for safe operations.

Considerations include:

- corridors flared at landings;
- corridors cut cross-hill where necessary to control runaway log hazard;
- corridor spacing appropriate for equipment;
- adequate deflection;
- minimal hazard created by lateral movement of skyline;
- windthrow hazard assessment.

Planners should:

- build safe work procedures into every aspect of logging operations;
- call upon the expertise of operations personnel for input on layout, reserve area locations, yarding corridors and residual tree selection;
- consider optimum economic and safety objectives in determining log lengths to be harvested;
- involve fallers in the determination of felling direction (or lay) at the planning stage, so that corridors of an appropriate width may be safely located, rub trees selected, landings appropriately placed, and the need for carriages with lateral yarding capacity, etc. determined;
- consider windfirmness in the location of cutblock boundaries and yarding corridors;

- walk riparian boundaries to ensure that danger trees with high wildlife value are protected by adequate riparian reserves or appropriate no-work zones;
- select for retention:
  - only firm, stable rub trees adjacent to harvesting corridors
  - leave-trees that will pose the least danger to workers (i.e., windfirm, healthy, with minimal crown hazard);
- consider the density and degree of decay in the existing stand, volume or basal area removal targets, and terrain:
  - Safety hazards increase with increasing stand density, stand decadence and steepness of terrain
  - Where timber is dense and decay is prevalent, the safer choice may be to harvest a higher volume to provide more room for felling and harvesting, or to leave retention patches (no-work zones);
- locate reserves in such a way that timber can safely be felled away from the reserve area;
- consider how reserve location affects the feasibility and safety of future harvest and silviculture operations within the block;
- establish windspeed shutdown criteria specific to the type, age and health of the timber on the block. Drainage and soil conditions should also be considered in formulating these criteria;
- prepare a detailed map or otherwise identify to workers:
  - prescription area boundaries and harvesting method
  - location of potential hazards, hazardous areas, danger trees
  - wildlife tree patches, riparian management areas, leave strips, no-work zones, and any other special management areas
  - logging corridors for dropline carriage logging systems, including all intermediate spars, back spars and tailhold stumps/trees
  - yarding corridors and landings
  - direction of yarding
  - guyline stumps
  - skid roads
  - access routes
  - emergency evacuation routes.

  This information will be used by workers to highlight and identify potential hazards and where safe operating procedures are required.

Engineer and faller discuss proposed harvest operations.

In the design of landings, planners should:

- provide a safe work area for landing workers, large enough to safely accommodate yarding and loading equipment, the landing and processing of logs, and the number of required log decks and vehicular traffic;
- provide enough space for safe bucking and limbing in whole tree logging operations. Consider sorting elsewhere, possibly in the mill yard, if other requirements dictate a small landing size;
- provide an adequate number of landings in appropriate positions to facilitate the yarding method employed;
- select locations that are suitable for level landing construction;
- ensure that landings are designed to provide adequate drainage, and that any excavated banks are stable and free of loose material which may roll/slide down onto workers;
- consider bucking and limbing or processing in the bush to reduce excessive slash accumulations on the landings.

In considering safe felling, planners should:

- discuss with the fallers and the logging supervisor:
  - the harvesting method to be used
  - the cut and leave-tree selection criteria for the cutblock
  - felling direction (or lay) as it relates to boundaries and reserves
  - hazards identified at the time of layout;

Supervisor, faller and engineer discuss the block.

- ensure that felling patterns and layout minimize the need for upslope felling wherever possible. Where upslope felling is necessary, the degree of slope, tree lean, and obstacles to movement (e.g., windfalls, loose material, broken ground) should be taken into account when deciding which trees to fell and in choosing a clear escape path. Trees should not be felled upslope greater than 15% from the perpendicular.

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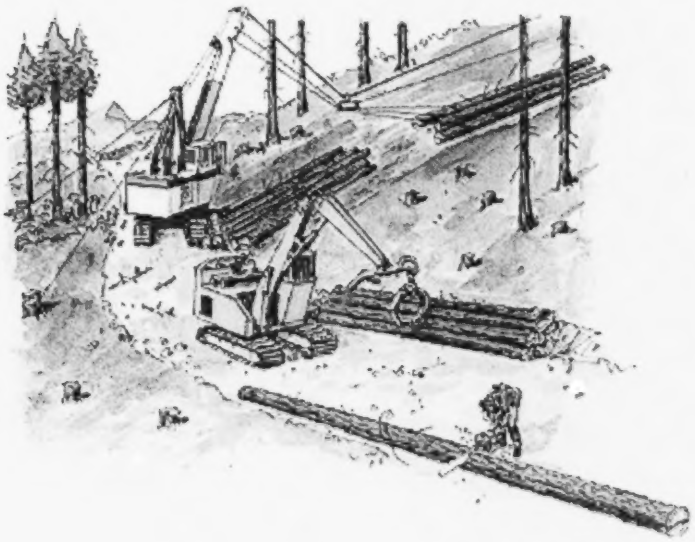
Designing Safe Cable-logging Methods

Landings

In the design of landings for cable-logging operations, planners must:

- provide enough room for the safe landing, processing and loading of logs: where there is not enough room to process or load the logs, they must be skidded away from the yarder to a more suitable area;
- ensure appropriate dimensions so that at least two-thirds of the length of each log can be landed on a flat surface for save chasing. Where this is not practical, some other safe means of landing logs (such as a brow log system) should be used;
- ensure that adequate guyline clearances for through traffic and loading equipment are available during harvesting;
- ensure that guylines in standing timber have a clear path for rig-up and yarding;
- ensure that adequate guyline anchor stumps are available, or that equipment, rock or soil anchors, or "deadman" anchors can be employed. Standing trees may not be used for guyline anchors if anyone would be endangered should the tree be pulled over.



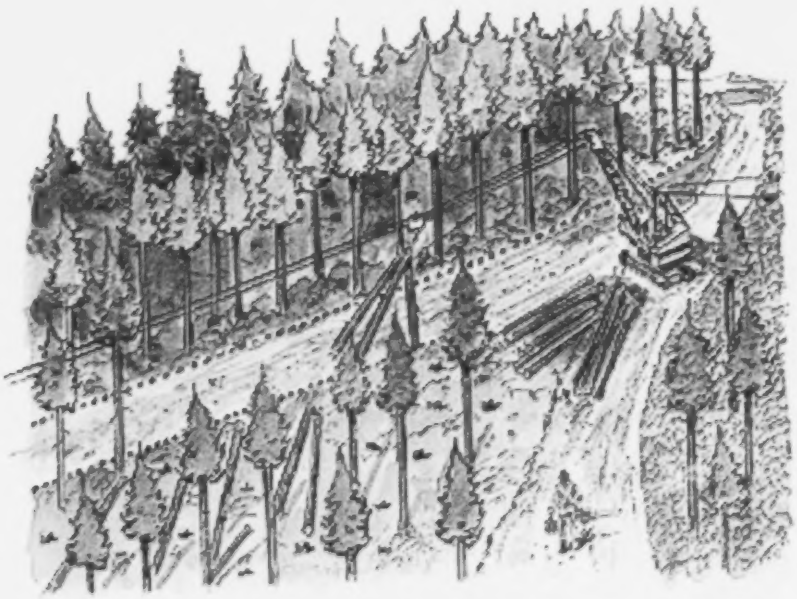
Loading and processing areas must be clear of log landing areas.

Yarding Corridors

- Planners should design well-engineered systems with correct corridor configuration (e.g., width, running line height, spacing) to:
  - enable the lateral yarding of logs into the corridor and prevent the turn of logs from hanging up on trees as the turn is yarded into the landing
  - avoid or minimize the danger that lines will strike and damage trees, creating hazards for the workers. Special consideration should be given to minimizing hazards created by skyline excursion during the lateral yarding of logs.
  - permit the safe yarding of maximum log lengths and swinging of the log turn during yarding.

  A well-designed yarding system may, in fact, utilize relatively narrow corridors.

- Planners should also:
  - plan for sufficient deflection where full suspension yarding is desired
  - ensure that deflection is adequate to avoid up-ending logs
  - consider flaring corridors at the landing if necessary for the safe landing and handling of logs
  - ensure suitable tailholds are available
  - ensure rub trees are free of unsafe defects, with stable roots; dead trees must never be selected for rub trees.



Mouth of corridor widened to prevent trees from being pulled over onto the machine or landing workers.

Downhill Yarding

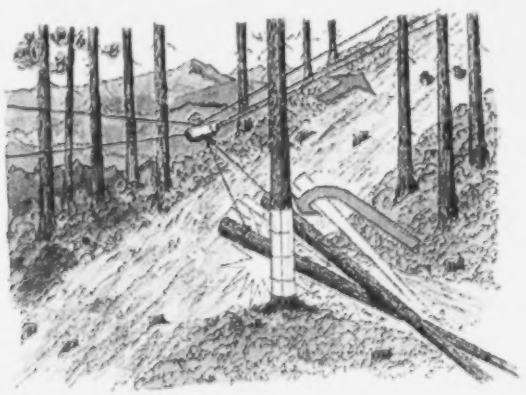
- For downhill yarding, plan for a yarding angle that will allow safe log landing and minimize the danger of runaway logs.
- Straight downhill yarding on steep slopes is prohibited because of runaway log hazard.

Uphill Yarding

- For steep uphill yarding on runaway-prone ground, the safest corridor orientation is a system of parallel corridors laid out sufficiently bias to the contour lines. This allows workers to clear to the upslope side of the turn more easily, ensuring that runaway logs slide downslope, away from workers.
- Although corridors laid out perpendicular to the contours make it easier to control logs during both the lateral and corridor yarding sequences and reduce damage to residual trees, straight uphill yarding is extremely hazardous and should only be used where the following conditions exist:
  - no other safe rig-up is possible
  - a site-specific determination of runaway risk has been made on the basis of local topography, ground and weather conditions, and proposed season of harvest
  - safe work procedures are followed to ensure that workers clear the turn and potential runaway areas before any yarding and/or loading activity is permitted. Workers must stay in this safe position until the rigging is spotted and any landing activity that has even the remotest possibility of dislodging material or logs ceases.

Cross-Slope Yarding

- Where cross-slope yarding must occur, full-suspension logging may be necessary to prevent damage to retained trees on the down side of the yarding corridors. This will require the use of live or standing tower skyline systems.
- Planners should identify and flag all corridors and access routes.



Consider protective devices to increase durability of rub trees.

Designing Safe Helicopter-logging Methods

Layout and Project Management Considerations

In the layout and design of a helicopter-logging system, planners, in consultation with helicopter operations staff, must consider the following:

- *Aircraft selection*: The selected aircraft must be capable of safely handling the anticipated log weight with sufficient clearance to avoid brushing the lower timber edge. Flight windows must be felled, if necessary;
- *Hazard assessment procedure*: Danger tree hazard assessment must be carried out on all designated wildlife trees/patches, riparian reserves, leave-trees, and any other potentially hazardous trees adjacent to the work area which could endanger workers. A no-work zone of sufficient size and shape must be established around any wildlife tree designated for retention;
- *Rotor blade downwash hazard potential*: All snags/danger trees that could potentially reach or endanger workers if subject to rotor blade downwash must be identified and removed;
- *Safe flight paths*: Flight paths must be selected which minimize exposure and risk to workers and vehicular traffic;
- *Roadway and traffic control/coordination of radio frequencies*: Effective traffic control and radio use is necessary to ensure flight paths remain clear of crews and support aircraft, and that travelled roads can be closed if overhead flight paths are necessary. A secure, uninterrupted radio frequency must be used for logging purposes;
- *Adequate buffer*: A suitable topographic barrier must be present on steep ground to prevent runaway timber from reaching workers downslope (runaway trees have been known to "run" 300–500 m through standing timber);

Plan turns to avoid overhead hazards and brushing of leave-trees.

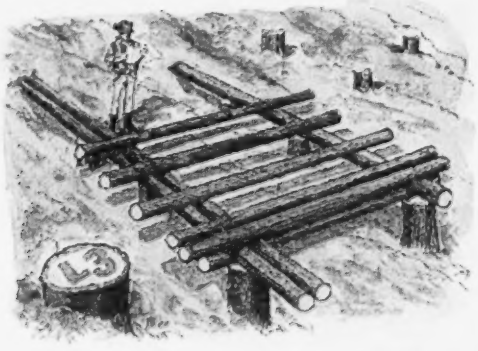
- *Emergency safety plan*: An emergency safety plan must be in place for logging or silviculture crews stranded on the hillside due to unexpected fog and storm events; this should include clearly marked exit trails and/or overnight emergency provisions. Such a plan should also provide for the removal of injured workers. Felling and bucking operations should cease if fog or storm events make it impossible to remove workers who may become injured.

Land-based Drop Zones

- Planners should:
  - ~ choose a level location/section of road for the landing drop zone
  - ~ design a drop zone large enough to facilitate the safe landing, chasing, decking and loading of logs, as well as an area for choker coiling
  - ~ ensure that flight paths will not cross active roads during logging (if that is not possible, planners should close affected roads, either with flagmen or gates)
  - ~ ensure the removal of trees and saplings adjacent to the landing which may be blown over or knocked into the landing.

Helipads

- Where helipads have not yet been built, planners should ensure that workers receive training in safe "toe-in" hover exit procedures.
- Vertical descent locations should be avoided in choosing helipad sites.
- Planners should ensure that helipads are designed and constructed to safely support the intended helicopter, and establish a regular safety inspection procedure for the duration of the logging project and subsequent silvicultural work.
- Standard helipad design and construction methods exist for a variety of helicopter types. General guidelines in the *WCB Helicopter Operations Manual* should also be followed.
- Planners and logging supervisors should refer to the standards in the WCB handbook *Helicopter Operations in the Forest Industry* and:
  - ~ locate helipads no more than 20 minutes walking distance from work areas
  - ~ ensure that workers are not routinely delivered to work area by means of "toe-ins" (hover exits)
  - ~ number and mark helipad locations in the field (e.g., on cut stumps), and indicate locations on the cutblock maps
  - ~ ensure that the date of construction of the helipad and the materials used have been documented.



Ensure helicopter pads are properly constructed, numbered, and marked on maps.

Inspection of Remaining Stand

The hazard assessment for helicopter-logging operations using helicopters capable of lifts exceeding 2250 kg must be to a standard that is more rigorous than that required for cable or ground operations because of the extraordinary disturbance caused by high rotor wash winds. This requires that the following steps must be taken:

- All standing dead trees that can reach or endanger workers must be felled, subject to safe felling procedures, as per established standard industry practice. Rotor wash can cause snags to fall against their lean and can dislodge bark and limbs. Snags that are blown over or broken on the upper boundaries of a steep setting can slide or roll downhill.

Falling supervisor assessing reserve tree.

- All standing green trees and saplings outside the block boundaries or adjacent to work areas that could endanger workers must be evaluated by a competent person who is familiar with the special hazards created by heli-logging, to ensure that:
  - ~ they are able to withstand helicopter rotor wash
  - ~ there are no overhead hazards.

  This evaluation must include a visual assessment (when possible) of:
  - ~ broken, burned, rotten or damaged roots
  - ~ trees with shallow roots, rooted in areas of poor drainage, or rooted on rock
  - ~ widowmakers, dead limbs, broken hanging tops, dead tops, loose bark, witches' broom
  - ~ excessive lean
  - ~ stem condition (scarring, cat face, cracks and splits, schoolmarms, fungal fruiting bodies)
  - ~ signs of root rot or other disease
  - ~ windthrow, indicated by cracked or disturbed surrounding soil
  - ~ other indicators of decay or physical damage.
- Trees that, by location or as determined by this evaluation, are not able to withstand helicopter rotor wash or will present a hazard to the logging crew must be removed.
- In partial cutting, all trees to be retained within the setting or block boundaries, as well as any suspect trees outside the block boundary, must be assessed as above, by persons who are familiar with the special hazards created by heli-logging and are certified wildlife/danger tree assessors. When possible, the assessors must apply the full wildlife/danger tree assessment to determine tree soundness and danger. However, the delineation of no-work zones is not permitted, and only trees determined to be sound and free from hazardous defect or excessive lean can be left standing during air operations. This procedure must provide verification of the evaluation of individual trees to be left standing.
- After felling and before yarding, a competent person must inspect the block and adjacent timber to ensure the removal of hazards created by the felling process or other harvesting activities.
- Heli-logging operators are responsible for ensuring that all the above requirements are met and that the crew will not be exposed to undue risk.

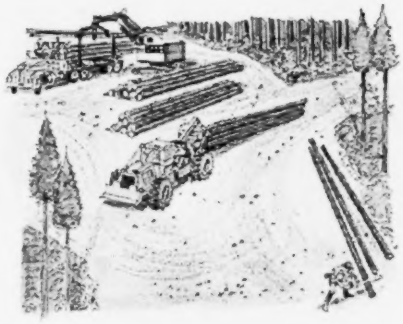
Designing Safe Ground-based Logging Methods

Layout and Equipment Considerations

- Trails should be oriented to provide for safe skidding of timber for both the current harvest operation and any future entries.
- The entire trail and landing network should be planned and laid out for complex harvest units prior to the initial entry. This will reduce the likelihood of hazards in subsequent entries.
- Harvesting patterns must be designed so that fallers can work a minimum of two tree-lengths from any other workers and avoid unnecessary brushing of other timber.
- During layout, planners should consider the specific types of equipment and equipment combinations to be used, taking into account:
  - space requirements of each type of equipment
  - safe maneuverability
  - maximum physical and economic yarding/winching distance
  - maximum piece size (weight and length) for equipment type
  - maximum reach of feller buncher/hoe to determine width of the crane zone and optimal trail spacing for mechanical/hoe-forwarding operations (the crane zone is the area on either side of the trail within which trees can be felled by the feller buncher/retrieved by the hoe-forwarder)
  - where wider trail spacing is desired, trees beyond reach of the feller buncher may be felled manually toward and into the crane zone
  - maximum winching distances to determine optimal trail spacing for cable skidding operations
  - slope limitations for equipment, which should not exceed 30% for skidders, 40% for crawlers and feller bunchers, and 50% for light flotation forwarders (check manufacturer's specifications).
- Planners should also take stand structure and health into account when specifying equipment. Slope limitations for equipment may be affected by the presence of windfall, debris, loose rock, broken terrain and high stumps. Tree height must be considered where manual felling is employed between crane zones to increase trail spacing.

Landings

- Planners should establish landings large enough to:
  - ensure the safe loading and chasing of the drag
  - accommodate loader movement between the truck and log deck
  - ensure safe tree processing and chain-filing/warm-up fire area
  - accommodate crew and emergency vehicle parking, and fire equipment storage areas
  - consider using self-loading logging trucks in tight operating situations; they can dramatically reduce landing size requirements because they can load at the roadside.

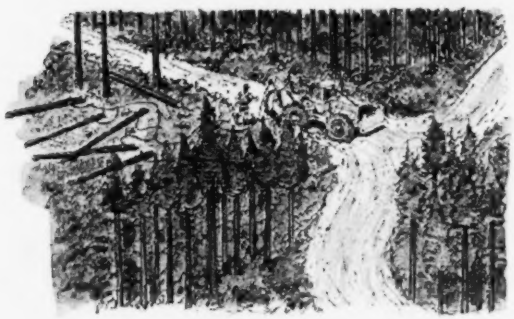


Ensure adequate room at the landing, or alternately schedule activities to ensure safe operations.

- Where landings must be small, the planners should consider:
  - limiting the number of skidders
  - using line or hydraulic grapple loaders or self-loading trucks that need less space and provide the flexibility of roadside decking and loading
  - increasing the number of landings and rotating equipment and workers between the landings.

Skidding/Forwarding Trails

- Planners should design the skid trail system so that:
  - it efficiently accesses all areas of the cutblock and does not place equipment in compromised winching, skidding, forwarding or loading situations
  - it takes maximum advantage of topographic features such as natural benches, stable/well-drained soils, moderate gradients, and natural deflection to facilitate skidding and minimize soil disturbance.



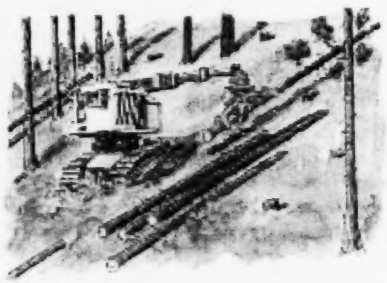
Utilize favourable grades and natural topographic features in locating skid trails to efficiently access the cutblock, facilitate skidding, and minimize soil disturbance.

- Avoid designing tight turns and right-angled corners by orienting skid trails to give angled access into the landing or roadside, or by creating wider trail-landing or trail-roadside junctions This is necessary to manage the hazard of trees made unstable by equipment striking trees when turning or by the logs sweeping into the landing.
- Intersections of more than two trails should also be avoided.

- Where terrain is uneven or partial-cut requirements call for tight turns, planners should consider using short/medium log lengths or gentle curves to minimize the sweep of the turn.
- Where trails follow contours, widths between the trails may need to be increased.
- The maximum grade of the skid trail must conform to the safe operating range of the skidding equipment under the worst weather conditions anticipated.
- Planners should establish safe trail widths that take into account equipment requirements, and reduce the potential for root damage and/or brushing/rubbing standing timber.
- Trails on steep side slopes will require greater width on corners because the turn may swing downhill. Planners should consider designing an in-sloped running surface for trails on steep side slopes.
- Planners should ensure that the bearing strength of the running surface can support machine traffic where bladed trails are required, in accordance with the Forest Practices Code *Soil Conservation Guidebook.*
- Planners should avoid locating trails in seepage areas unless appropriate environmental protection, drainage structures and/or protective measures are utilized.

Mechanical Felling

- Planners are responsible for specifying the required size and capacity of the mechanical feller.
- Mechanical felling should not be considered on slopes over 40% unless adequate written procedures are implemented to ensure machine stability.
- Areas where mechanical felling is prohibited should be identified on a map, and the boundaries marked in the field. A copy of the map should be kept in the cab of the machine.



Do not exceed safe operating limits for equipment.

Skidding/Forwarding

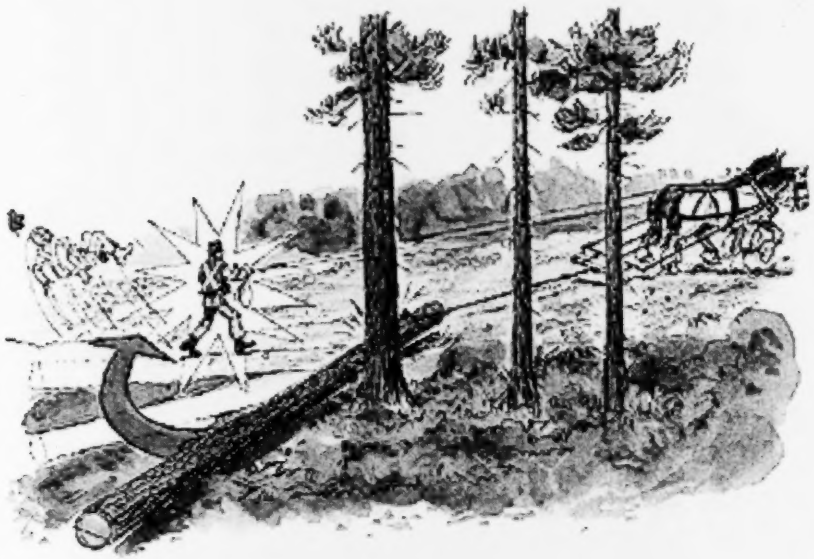
- Planners should:
  - ensure that equipment is matched to the site
  - ensure skidding and forwarding is conducted in a safe and controlled manner to prevent "roll-over" events
  - select stable rub trees free of defects and firm enough to prevent skidding damage to the residual stand. Standing dead trees or danger trees should not be selected as rub trees
  - ensure skidding and forwarding are conducted in a manner which minimizes damage to leave-trees.

Consider protecting rub trees to reduce bark damage.

Designing Safe Horse-Logging Methods

As with other methods of logging, most accidents in horse logging occur during felling and bucking operations. Planners, in consultation with the teamster/faller, should:

- lay out the work area in such a way that both the faller and teamster can maintain a safety check on one another;
- avoid logging on side slopes where there is the risk that logs may roll down the hill onto the teamster and horses (e.g., slopes generally in excess of 10%);
- design armoured turns to reduce damage to standing trees (horses can't be backed up to move the load if in a bite);
- lay out the work area to accommodate the felling, bucking and skidding of appropriate log lengths, and meet leave-tree selection criteria.



Avoid exposure to the risk of pivots and swinging logs.

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Section Two

Working Safely in Partial Cuttings

Carrying Out Logging Operations

The forest development plan and the silviculture prescription have been approved and a cutting permit issued. The approved plans have been reviewed and copies given to the licensee and/or contractor. The logging supervisor and his workers are preparing to carry out the logging.

Before operations begin, everyone involved must be reminded that there are unique hazards to working in standing timber. Workers must be alert at all times to the hazards around them. Each worker will be responsible for making decisions on the ground and communicating them to his/her supervisor and fellow-workers.

Similarly, supervisors must clearly communicate to workers the plan/silviculture prescription objectives and operational standards required to successfully implement logging operations.

SAFETY FIRST!

Step 1: Always read and understand your plans and maps.

Step 2: Always match your plan and maps to what you find on the ground, and then check that you can safely do the work.

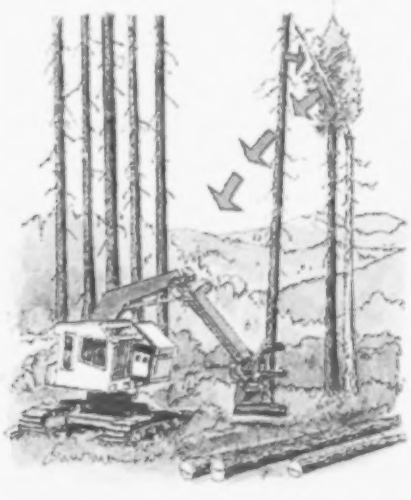
Step 3: If you cannot safely follow the plan and map, stop and ask.

Step 4. Know your abilities. Ask if you are not sure.

General Procedures

- To ensure that safety is maintained during partial cutting, planners, logging supervisors and workers must be aware of:
  - ~ potential harvesting restrictions and operational considerations such as excessive soil moisture, extreme weather conditions and difficult terrain
  - ~ previously unidentified resource features (e.g., discovery of a raptor nest in a danger tree that will require establishment of a no-work zone)
  - ~ the particular hazards unique to the type of partial cutting being done.
- Logging supervisors must establish a work plan to ensure that felling and yarding operations are kept separate, and that the mancheck/buddy system is not compromised by equipment and noise.
- Logging supervisors should establish regular pre-work meetings to provide an opportunity to discuss potential hazards (broken tops, yarding and skidding conditions, etc.) with the logging crew. Tailgate sessions are particularly useful to review plans, clear up problems, and review job safety breakdowns.
- Logging supervisors must establish a shutdown policy for fog, wind, rain, soil disturbance and mechanical problems, and ensure this policy is followed: wind concerns, for example, are crucial in partial cutting because of the potential for windthrown trees and falling limbs.

- Logging supervisors must:
  - ensure that the work area is thoroughly inspected for windthrow hazards after significant storm events, especially after weekend storms
  - remove such hazards before operations continue.
- Logging supervisors will:
  - assess the field site for hazardous conditions
  - stop any unsafe work and get the issue resolved
  - maintain communication with the planner throughout the project to anticipate and resolve problems.
- Logging supervisors should set up and monitor the "two tree-length" rule, especially where there is reduced visibility between equipment operators and other workers.
- Logging supervisors and workers are responsible for ensuring that landings are not overfilled and are used within design specifications.
- Logging supervisors should ensure that:
  - well-marked walk-off routes are noted on all maps, known to workers, and clearly marked at the site to allow evacuation of injured personnel
  - all danger trees within reach of work areas have been removed.
- Workers must be aware that visibility is obscured when working under a partial canopy and:
  - wear high-visibility vests at all times
  - make frequent sound checks or visual checks
  - be familiar with the felling plan on a daily basis
  - maintain at least two tree lengths between fallers, and between fallers and other workers.



All danger trees must be removed progressively.

Weather

Wind

Some types of partial cutting expose the interior of the stand to wind, causing non-windfirm trees (especially shallow-rooted species on thin or saturated soils) to be blown down more easily.

- The logging supervisor should establish windspeed shutdown criteria that take into account:
  - seasonal wind patterns and the exposure of the site
  - tree species—some have more stable rooting habits than others
  - the quality and health of the stand. Unhealthy trees tend to have hidden hazards (e.g., unstable rooting systems of trees growing on windfalls, weakened roots and stems of diseased trees)
  - shallow and/or poorly-drained soils.
- Workers should locate access/exit trails to control exposure to blowdown risks during winds in heavily-thinned partial cuts.

Locate escape trails in partial-cut work areas to avoid worker exposure to blowdown risk during high winds.

Snow and Frozen Timber

- The logging supervisor must establish shutdown criteria for heavy, wet snow and extreme cold conditions.
- Workers must be aware of the danger of:
  - snow-laden treetops and brittle branches breaking off more easily
  - heavy clumps of snow falling off trees
  - whiteouts that may occur from felling snow-laden trees, and obscure overhead hazards
  - impaired visibility resulting from heavy snowfall
  - the weight of snow on snags causing them to fall out of the standing timber into the active work areas
  - the risk of tripping when walking through felled and bucked timber covered with snow
  - not being able to see snow-covered bucked logs which may up-end or swing when yarded
  - logs and equipment unexpectedly sliding on ice or snow.

- Fallers must:
  - avoid working where snow-laden canopies make felling unduly hazardous
  - watch for:
    - direction of lean caused by additional weight of snow —for example, saplings may fall in the direction of the weight, regardless of the undercut and holding wood
    - snow-laden branches breaking off without warning.
  - be aware that:
    - dry snow accumulation may impede the ability to detect widowmakers and loose limbs that could be thrown back during the felling process
    - a cloud of dry snow occurs as the tree is falling, creating a whiteout that will last several seconds and obscuring overhead hazards
    - sprung limbs, pivot points, loose logs and depressions in the ground may not be detected when logs are bucked in snow
    - felled and bucked trees can slide unpredictably in snow.

Whiteouts from felling snow-laden trees may prevent the faller from seeing heavy clumps of snow or broken branches dislodged from the crown.

- To avoid the danger of the wedge kicking out during the felling of frozen timber, the faller should insert a second wedge or use wedges that are appropriate for the time of year (some wedges stick better than others in frozen wood).
- Fallers must establish well-made "getaway trails" to cope with decreased mobility in snow.
- Fallers must establish a special safe work plan where snow shovellers are employed:
  - Two "getaway trails" must be dug out from the trunk of the tree if the snow level is more than 40 cm deep
  - Shovellers must maintain a minimum two-tree-length distance from the felling activity
  - Shovellers must never work downslope of a faller in the hazard area
  - Snow clearing must be done in a manner that allows the faller full access to the tree.

Excessive Rainfall

Excessive rainfall may increase the risk of debris torrents and landslides. Many coastal operations have unstable terrain or the potential for debris torrents on slopes above work areas.

- Workers should be familiar with the local history of landslides on steep, water-saturated slopes.
- The logging supervisor must shut down the operation when there is a danger of mud and rock slides or debris torrents.
- Workers must be alert to the dangers of mud/rock slides and debris torrents, and learn to recognize the early warning signs.

When the ground is saturated, shallow-rooted trees and trees growing on thin soils may blow down even during minor winds.

- Workers must be taught to recognize poorly-drained and saturated soils, because trees growing on these sites will have shallow root systems and be especially prone to windthrow compared to trees growing on well-drained soils.
- Workers must be aware that the root system of trees growing on saturated soils are more easily disturbed and that whole root systems may pull out of the ground if the tree falls.
- Heavy rainfall can reduce the ability to hear nearby workers and equipment.
- Muddy conditions may place additional strain on rigging, skidding and yarding equipment, resulting in breakage and dangerous situations.
- Operations must cease if rainfall shutdown criteria are exceeded.

Fog

- The logging supervisor must suspend operations where excessive fog seriously impairs visibility.
- Workers must be aware that they may not be able to see the lay of the logs, thereby increasing the hazard of not seeing up-ending and swinging logs.
- Workers must be aware of the danger of the haulback dislodging logs, roots and stumps that they cannot see.
- Yarding crews may lose sight of the turn of logs and not be able to see potential problems as the turn is yarded to the landing.
- Fallers must be able to see the top of the tree to check for overhead hazards.

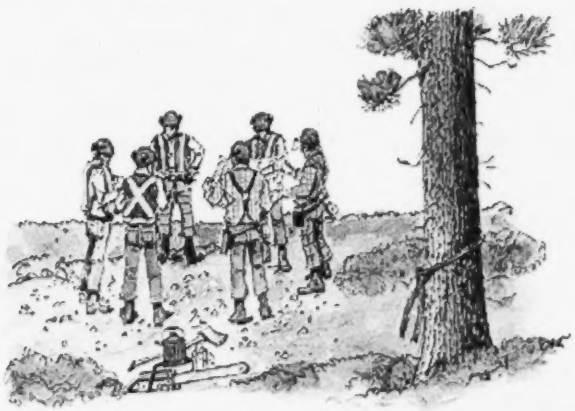
Bright Sun

- Workers should carry out frequent visual checks if glare is likely to prevent them from detecting potential hazards.
- Workers must pause to let eyes adjust when moving from bright sun into shade and vice versa.
- Workers must anticipate windshield glare that may occur while moving from the shade of a partial canopy into cutblock openings.

Felling in Partial Cuttings

Training and Preparation

- Fallers must be familiar with the Workers' Compensation Board Industrial Health and Safety Regulations and the *Fallers and Buckers Handbook*.
- New fallers should be trained at least to the WCB Faller and Bucker training standard, preferably by fallers with partial-cutting experience. Experienced fallers should review the training program periodically.
- Fallers unfamiliar with partial-cutting operations should participate in a documented review of standard safe work procedures and a basic job safety breakdown, with particular emphasis on felling direction accuracy, increased potential for brushing, and upslope felling limitations.
- Fallers should attend pre-work meetings with supervisors and planners to:
  - understand the management goals and objectives of the silvicultural system being applied, and its limitations
  - address problems that may pose risks both to fallers and, later on, to logging crews
  - ensure that the harvesting method, windthrow management, disease and pest control, and visual quality objectives are understood and can be safely met
  - ensure that tree selection criteria for the whole block and criteria to fell alternate trees are clearly understood
  - consider tree placement, bucking length, and safe-lifting weight requirements for safe and efficient yarding in cable, helicopter, ground-based, and horse-logging operations.



Pre-work conferences with fallers are essential to safe logging operations.

- Fallers should check to ensure that field maps clearly identify:
  - prescription area boundaries
  - harvesting methods and equipment to be used

- any objectives for non-timber forest resources that may impact harvest operations, including prescriptions for riparian management areas, wildlife tree patches, and gully management areas
- yarding corridors and landings
- direction of yarding
- skid roads
- access routes
- emergency evacuation routes
- hazards and no-work zones
- locations of all reserve areas, including wildlife tree patches and riparian reserve zones
- locations of all special management areas including riparian management zones
- locations of machine-felling areas.

- Before beginning operations, fallers should walk the work area to:
  - fit the plan to what is on the ground, determine if the objectives of the plan can be met safely and confirm that the field layout is consistent with the map
  - confirm the feasibility of the felling plan
  - consider the implementation of tree selection criteria and the objectives for the chosen silvicultural system
  - confirm the feasibility of tree-placement and bucking length requirements
  - understand the objectives for leaving reserves in the block
  - identify on the ground all riparian management areas (RMAs), wildlife tree patches (WTPs) and other special management areas shown on the field map
  - take into account ground slope, timber type and lean, and the density of the top canopy in preparing to selectively fell timber (this is especially important within the narrow openings that may result from the establishment of RMAs)
  - identify all potential problems which the supervisor will be required to control
  - develop an on-site safety work plan with felling partners and other workers to include safe work areas with a minimum two tree-length separation, an effective mancheck system, identified emergency evacuation trails, and a safe work procedure for each work day
  - ensure that personal safety programs are not compromised.

- Fallers should be especially aware of:
  - overhead hazards when working in stands with old-growth characteristics (e.g., patchy, uneven-aged trees of various sizes, form, health and lean)
  - hazardous hang-ups and brushing damage to residual trees when working in stands where the objective is to leave a uniform distribution of residual trees.

Cutblock Design

Poor cutblock design may prevent fallers from safely accomplishing specific management objectives. Improper or poor selection of leave-trees can create potential hazards for felling and yarding crews, especially where stands have a high proportion of unstable trees and overhead hazards. For example, the timber lean may be away from one site boundary, but the trees selected for removal could be of a height that the tops will fall into an RMA or WTP in a narrow logging layout.

The same situation might be encountered with parallel boundaries, where the block has been engineered on narrow benches below steep, inoperable slopes. Similarly, V-shaped RMA junctions may restrict safe cross-slope felling of trees when opening up the lower face of a block.

Difficulties may also arise when management objectives are incompatible. It may be impractical to retain wildlife trees if the goal is a uniform distribution of leave-trees. The overlapping no-work zones for even a small number of designated wildlife trees would necessitate leaving group reserves (e.g., WTPs) rather than uniformly distributed leave-trees. This may make the block design unworkable.

The faller must stop work immediately if his safety or the safety of the crew is endangered. He must contact his supervisor immediately to develop an alternate plan. He may need to work in another area until the supervisor gives instructions.

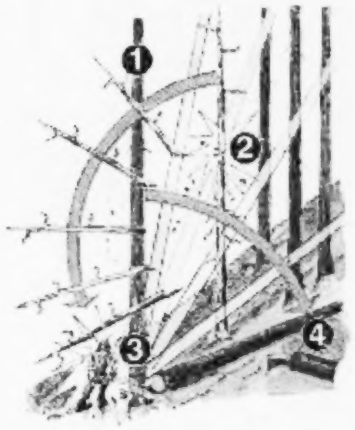
> *Considerations of safe felling practices (e.g., safe cross-slope felling and felling adjacent to WTPs and NWZs) must be incorporated into cutblock design.*

Felling Corridors or Trails

- If ground conditions permit, fallers should first fell all yarding corridors (and trails to all corridors). This will provide safe work areas for the faller and his partner once felling in the remainder of the block begins.
- While felling corridors or skid trails, the faller must maintain an adequate distance between the skidder and other on-site workers and equipment.
- Field maps should be referenced frequently to confirm current location and ensure that a minimum two tree-length distance is maintained between the faller, other workers, and logging equipment.

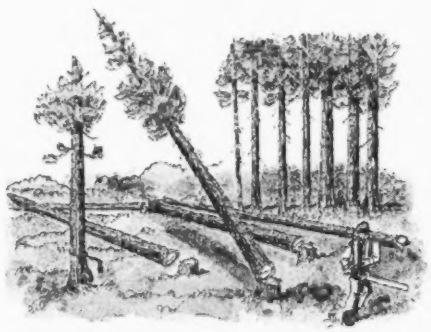
Felling Among Leave-Trees

- Fallers are responsible for the final selection of trees to be felled and the direction of felling; poor directional felling will create yarding hazards for the harvesting crew.
- Fallers must minimize brushing of residual trees because:
  - the tree may become lodged, creating an additional hazard
  - loose limbs and tops or widowmakers may be tossed back towards the stump and strike the faller
  - hidden danger trees and snags can break loose and fall towards the faller
  - canopy hazards may be created for the yarding crew.



Be alert to the danger of hidden snags that can break loose and hit the faller.

- Fallers must observe visibility limitations and adjust their procedures accordingly to evaluate overhead hazards (e.g., do not fell trees if foggy conditions make it impossible to see the tree tops).
- Fallers must discuss all changes to the daily workplan with the other fallers to ensure that safe work distances are maintained between them.
- Fallers must take care to remove any trees that, when brushed, may pose a hazard to workers (e.g., deciduous trees often have a large canopy and the dead limbs can be very brittle, creating a safety hazard).
- Fallers must pre-plan escape routes to safe locations a sufficient distance away from the stump of the tree being felled.
- When seeking a safe location, fallers should move at least three metres back and away at a 45° angle to the uphill side of the stump.
- Fallers should take cover behind a tree and stay sheltered until the felled tree is on the ground.
- Fallers should contact the supervisor if a dense tree canopy restricts the felling of selected trees. The plan may have to be modified to address safety concerns.
- Fallers should avoid pushing timber except to overcome a felling difficulty. In such cases, a wedge must be driven into the back cut of all cut trees. Domino felling is prohibited.



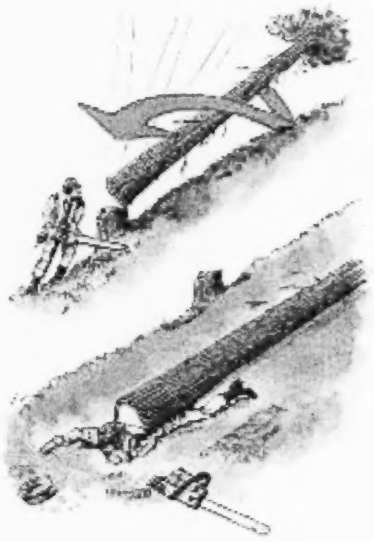
Avoid unnecessary brushing of leave-trees.

Saplings in the felling path must be removed where they pose a potential danger.

- Fallers must remove saplings if there is a danger that the saplings may spring back when the larger trees are felled.
- Fallers must carefully assess any standing tree for overhead hazards or damaged roots; if it is a danger tree it must be felled.
- If the faller cannot safely dislodge widowmakers left hanging in the canopy, he must notify his supervisor, flag the hazardous tree, and establish a no-work zone with the appropriate flagging.

Felling on Steep Slopes

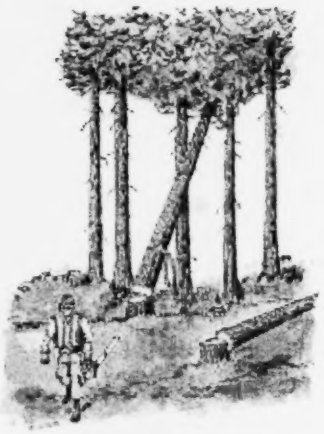
- Patches/groups of trees on steep slopes should be felled side-slope or slightly uphill across the hillside to hold the timber on the slope for safe bucking.
- Fallers must avoid felling directly up steep slopes because:
  - ~ the tree is more likely to kick back and/or slide back downhill
  - ~ trees are more likely to be brushed, causing broken portions to fall or roll downhill towards the faller
  - ~ there is a greater chance of the butt flipping up, down, or even sideways if the ground is uneven, placing the faller at risk of being struck, thrown into the air, or pinned
  - ~ the tree is less likely to be positioned for safe bucking because of the sliding hazard.
- Be cautious of constricted cutblock configurations or V-shaped RMA junctions, which may restrict cross-slope felling and force the faller into an uphill felling situation.
- If uphill felling cannot be avoided, the faller should try to fell the tree at an angle no greater than 15° upslope.



Never fell directly up steep slopes.

Hung-up Trees

- If a tree being felled strikes a leave-tree and hangs-up, the faller must develop a safe work plan to remove it. Similarly, the faller should check to see if residual trees are damaged. Danger trees must be removed before further work is done in the hazardous area.
- If the faller considers the situation unsafe to fell, he must first conspicuously mark the danger (lodged/damaged) tree and alert any other workers who may enter the hazardous area. The supervisor must also be informed, and is responsible to ensure that the hazard is removed by a safe alternative method, such as using a machine or blasting.



Fallers have the right to walk away from unsafe conditions, but must close the area first.

- A faller always has the right to walk away from a hazard created while felling or bucking, as long as he first marks the hazard, closes the area to other workers, and notifies the supervisor.

> *Regardless of the tree-marking system (marked-to-cut or marked-to-leave), the faller always has the final choice which trees may be safely cut, which trees can be safely retained, and the sequence of tree cutting.*

Bucking

- Fallers should ensure that bucking cuts do not impede the rigging crew's ability to remove the logs from around the leave trees.
- Fallers must assess trees to determine any bind that may be present, and what direction it will shift during bucking, especially on steep slopes.
- If a tree is bound within standing timber, the faller must determine how to buck the tree and stay clear of the sweep of the log as the bind is released, and how to control the danger of pivot points.
- Fallers must properly buck all logs, to facilitate safe yarding.
- If a bucking cut cannot be completed safely, the faller must leave it, mark/flag it, and notify the supervisor at the end of the shift.
- Fallers should be aware of loose logs, root wads, rock outcroppings, stumps, windfalls and hidden ground debris, and adjust their position accordingly.
- Fallers should remember the fallers' adage, "look up, look down, look around" in all partial-cutting operations.

Danger Trees

A danger tree is any tree that endangers workers because of:

- *excessive lean over the work area, or*
- *physical damage, or*
- *overhead hazards, or*
- *deterioration of limbs, stem or root system, or*
- *any combination of the above, or*
- *any tree that interferes with safe felling, yarding or loading.*

Danger trees and associated hazards.

Danger trees must be managed during all phases of partial cutting—pioneering right-of-ways, road and landing construction, felling, yarding, loading, hauling and road deactivation.

- Fallers can recognize danger trees by these warning signs:
  - excessive lean (>10%–15%)—exposed roots on leaning trees indicate possible previous damage from adverse weather conditions
  - root-rot—shown by loss of needles in the crown; in advanced cases, the tree may have dropped all needles and is already dead
  - black seams—indicate a hollow trunk or one that is severely rain-checked or diseased
  - fungal growths on the trunk and at the base of the limbs—indicate a decayed tree that could fall once surrounding trees are felled
  - weakened sections of the trunk caused by cat faces, school marms, forked stems or radial cracks
  - significant mechanical damage to bole or roots
  - large dead, broken and hanging limbs, large forked and dead spike tops, broken tops, loose bark, large witches' broom (>1 m diameter) or any loose debris in the crown that could easily be dislodged and fall.
- Fallers should remove danger trees as soon as it is safe to do so, or establish appropriately flagged no-work zones around them.

- Before felling danger trees, fallers must:
  - ensure that they are not designated wildlife trees (these must be protected by a no-work zone or wildlife tree patch)
  - develop a clear felling path so that the tree will not toss debris back towards the faller
  - clear an escape route to a pre-planned safe area.
- If a danger tree cannot be safely removed, the faller must establish a no-work zone. All workers must be alerted to the location of the no-work zone and its location marked on all field maps.
- Following consultation with the supervisor, if a danger tree cannot be located in a no-work zone or felled safely, it must be removed with explosives or by other recognized safe means.

> *Trees adjacent to a cutblock boundary which are felled for safety reasons must be left on site, unless approved for removal by the Forest Officer. Never cut trees outside the cutblock boundary, unless required for safety reasons.*

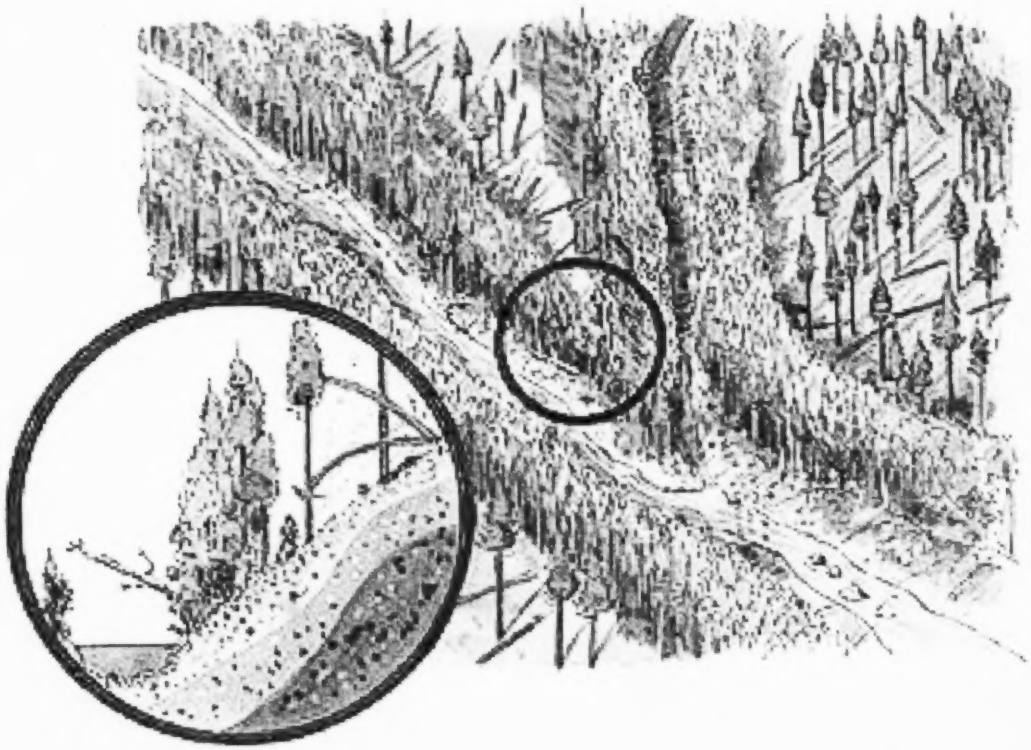
Felling Near Riparian Reserves, Wildlife Tree Patches

- Fallers should be aware of the cutblock boundary flagging and request additional flagging if standing timber obscures existing flagging and blazing.
- Fallers should be knowledgeable of the felling opening and face plan.
- Fallers must not fell blazed boundary trees of reserves and the cutblock except to overcome a felling difficulty. If the tree needs to be removed, it must be felled above the painted blaze mark so that the boundaries can easily be identified. If the blaze is too high, the faller may fell it below the mark, but the stump should be marked again.

The locations of riparian reserves and wildlife tree patches must be clearly identified on maps and in the field.

- Because riparian reserve zones are seldom engineered in straight lines, and because trees will tend to develop limbs and lean towards open areas, fallers may have difficulty keeping the timber in lay. If a faller cannot safely fell the selected trees, he must notify his supervisor. The felling boundary may need to be adjusted by the planner.

- After careful assessment, fallers may consider using tree jacks to fell a tree into the work area when it leans towards a reserve or wildlife tree patch (see *Faller and Bucker Handbook*). Fallers must not jack trees suffering from root-rot, or poorly rooted trees. If wedging is likely to be inadequate, they must advise the supervisor, who may consider cable attachment to pull the trees over. Otherwise, they should not be cut.
- When felling along backlines, sidelines or riparian reserves, it is often necessary to change the felling direction or even fell across streams until a sufficiently wide operating area is established. Upon changing direction, the faller should be particularly wary of logs being flipped back or around by the felled tree.



Narrow block configurations and v-shaped RMA junctions may restrict safe cross-slope felling.

- Where winding boundaries narrow cutblock design or v-shaped RMA junctions do not allow for keeping felled timber in lay or restrict safe cross-slope felling, the faller must notify the supervisor to have the felling line moved. This may require an amendment to approved plans. Areas where uphill felling is prohibited must be ribboned out.
- Fallers may enter riparian reserves or wildlife tree patches to fell danger trees where a safe danger tree removal procedure has been identified in the work plan, but felled trees must be left on site until approved for removal by the Forest Officer.

- Where a high-quality wildlife tree outside the block boundary or within a riparian reserve/wildlife tree patch endangers workers, fallers should adjust their work pattern away from any danger and flag an appropriate no-work zone until a qualified assessor evaluates the tree for protection or removal, depending on stand-level management objectives.
- Hazardous wildlife trees designated for retention must be adequately buffered by a wildlife tree patch or appropriate no-work zone established along the cutblock boundary.
- Where the establishment of no-work zones interferes with the felling pattern in the adjacent work area (e.g., work area now too narrow to avoid felling trees into the reserve or over the boundary) the faller must cease work and notify his supervisor to develop an alternative felling plan.

> *It is especially difficult to retain wildlife trees in partial-cutting situations where the primary objective is to leave a uniform distribution of residual trees. Overlapping no-work zones will often necessitate leaving groups of residual trees (e.g., wildlife tree patches) rather than uniformly distributed leave trees.*

Click here for next page

Tree Climbing: Crown Thinning and Topping

Crown thinning and topping are effective procedures for preventing blowdown in retention areas (e.g., riparian areas, wildlife tree patches, leavestrips along roads) by reducing the wind sail capacity of the crown. However, there are special hazards associated with this relatively new practice in the forest industry.

General Procedures

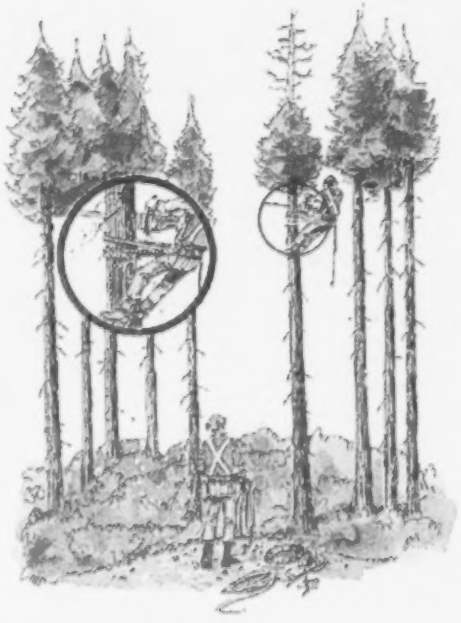
- Climbing must be done safely, and not governed by production quotas.
- Climbers must be properly trained and experienced in recognized safe climbing, crown thinning and topping techniques.
- Climbers must be properly trained and experienced in the use of climbing equipment, ropes, cables, rigging and tree service tools.
- Climbers must use certified and approved climbing equipment.
- Climbers must routinely inspect climbing equipment for wear and fatigue, and must replace suspect gear immediately.

Pre-Climbing

- Climbers must ensure that site-specific emergency procedures and equipment for tree top rescue are in place before climbing.
- Climbers must ensure that there is a support person on the ground, capable of climbing up and performing an emergency rescue.
- Climbers must ensure there is a spare set of climbing equipment on site.

Climbing

- Climbers must not climb a tree until they have made a full assessment of the safety of the tree, using the procedure outlined in the wildlife/danger tree assessor's course. Climb only class 1 and 2 trees, or class 3 trees that have been bored and assessed as safe for climbing.



Tree climbers must always have another qualified climber capable of rescue immediately available on site.

- Climbers must pay particular attention to:
  - the size of the tree
  - the tightness and thickness of the bark
  - root damage and rot
  - widowmakers
  - hazardous lean
  - pocket rot, cat faces, fungal fruiting bodies.
- Climbers must not climb:
  - in strong winds (the actual safe wind speed will depend on site-specific conditions)
  - in fog (tree tops must be visible)
  - where there is a snow hazard
  - where there is a frozen wood hazard
  - during, near or immediately after an electrical storm
  - in areas made hazardous by adjacent danger/standing dead trees.
- Climbers should use a rappel line for safety and to reduce fatigue.
- Climbers must assess the stem for soundness on the way up.
- Climbers must use a second safety/flip line to climb past limbs.
- Free climbing is not permitted.

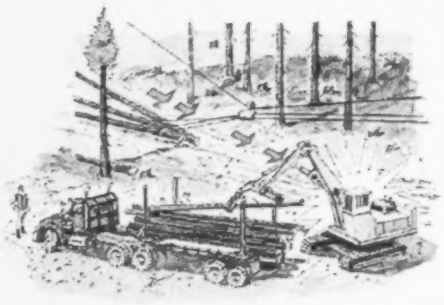
Topping

- Climbers must not top a tree with an unsound stem.
- Climbers should hook and safely tie a chain around the circumference of the tree, immediately below the topping cut, if they feel the tree bole could split downward during the topping process.
- In topping trees, climbers must:
  - use proper cutting sequence to ensure the tops fall clear
  - use proper safety equipment
  - carry a wedge and small axe for wedging the top in the desired direction
  - ensure the ground spotter is in the clear
  - ensure that falling tops do not get hung up in adjacent trees.
- When topping leaning trees around creeks, climbers may require a rope tied to the top to pull it in the desired direction, away from the creek. Tops with a slight lean may be wedged in the desired direction.

Safety Check List for Cable-logging Methods

Landings

- The logging supervisor must ensure that:
  - the landing area is large enough to safely accommodate all landing activities
  - all guyline clearances are felled and stumps, engineered rock bolts, etc. are used to anchor guylines
  - the loader and trucks are not in lead with incoming turns or subject to hazards of runaway logs, loose rock, rolling root wads or broken yarding lines
  - any trees that could interfere with rig-up, the movement of lines and equipment, or otherwise be pushed or pulled into work areas, be removed
  - landings are stable and relatively flat
  - cutbanks are stable
  - log piles are stable.



Loaders should not work in lead of incoming turns.

Yarding Corridors

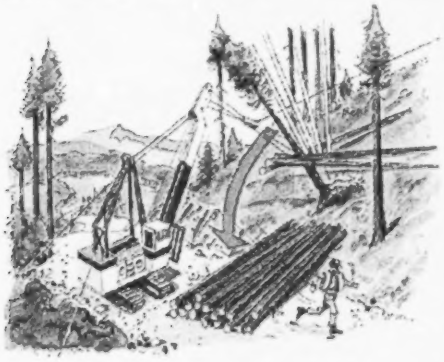
- The logging supervisor must ensure that:
  - rub trees are well-rooted and windfirm; consider topping if necessary to improve stability
  - deflection is adequate to avoid up-ending logs
  - the hazard of runaway logs, chunks, rocks and stumps is controlled
  - rigging workers are not exposed to potential runaways.
- Corridors should be reflagged at roadside after felling is complete.

Rigging

- The logging supervisor must ensure that:
  - rigging lines through standing timber run free and clear
  - the skyline does not strike trees in the residual stand
  - the skyline is never overloaded
  - backspars and intermediate spars are properly rigged
  - backspars are properly topped by qualified climbers
  - fibre or cable slings and all other rigging gear are regularly inspected
  - all hazards must be identified and removed, or appropriate no-work zones established.
- The logging supervisor should ensure the use of skyline jacks with sheaves of material softer than the skyline.

Yarding

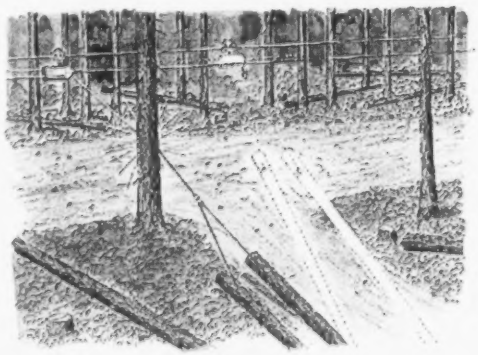
- The logging supervisor must ensure that:
  - neither logs nor lines get hung up in standing timber
  - loading and yarding crews do not create hazards for each other, especially when the rigging crew is in or near the landing
  - trees or saplings will not be pulled over or pushed into the landing.



Remove any trees that may be pulled into the landing by the turn.

- The yarding crew must:
  - not work below unstable slopes or any areas with the potential for runaway logs, root wads, boulders or dislodged snags/danger trees
  - not work in the bight of moving lines or of trees that could be pulled over
  - ensure logs are in a stable position before setting chokers
  - stay well clear of any rigged spar trees under load/tension
  - avoid rubbing leave-trees by machinery or cables
  - monitor overhead hazards and trees made unstable by logging activities or wind events
  - immediately remove any rub trees that become unstable as a result of yarding
  - know and observe the wind speed and rainfall-based shutdown criteria.

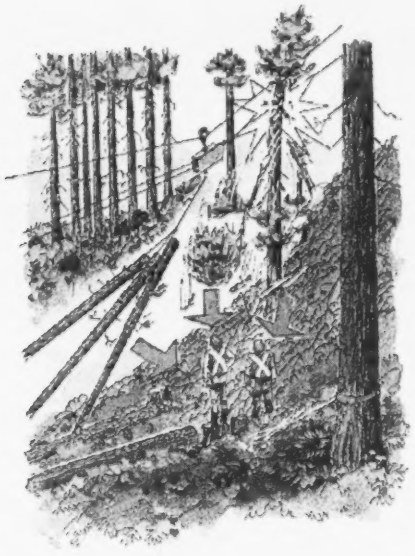
Position carriage to minimize line contact with rub trees.



Safe Location

Workers must always locate a "safe location" and position themselves "in the clear."

- In order to be in the clear before moving the turn:
  - workers must be positioned behind and preferably above the turn so that they are beyond the arc of any log that might swing or up-end, and enough to the side to be well beyond any possible movement of the lines, grapples, carriage or rigging
  - if a safe location is not available behind the turn, workers may go to the side of the turn provided they are a distance at least twice the length of the longest choked or grappled log. Swinging logs may strike something, break and shower workers with debris, or may fly through the air for a distance limited only by the length of the choker and the rigging. Break the turn out slowly and "go ahead" slowly until the logs are in lead with the skyline.
- Workers must be facing the turn prior to a "go ahead" signal.
- On steep ground, various activities of yarding, landing and loading can dislodge logs and other material that can run away or roll downhill, possibly endangering workers. The work area must be evaluated to determine if the potential for this hazard exists. If the hazard exists, the setting must be logged in a manner that will ensure that workers are not positioned in the potential path of these rolling and runaway hazards. It is not acceptable to rely on constant vigilance and fast reaction time to outmanoeuvre the moving material, or to cower behind a tree or stump in the hope of avoiding injury.



Workers must stay in safe locations to avoid overhead hazards and swinging of the log turn. These workers are not in the clear.

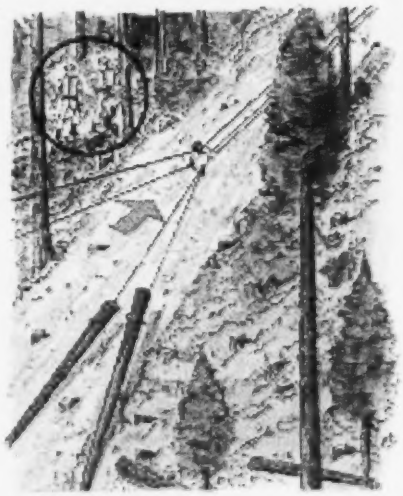
- When uphill yarding in steep runaway-prone areas:
  - yarding roads should be laid out sufficiently biased or cross-slope such that when the crew clears the turn (preferably behind and above) and signals "go ahead," any dislodged material will move away from the crew
  - the area must be logged such that each yarding road is progressively lower than the previous road and the crew clears upslope, into the previously logged-off area, thus above the turn and not below any felled timber that could roll if disturbed
  - attempting to progress uphill with successive yarding roads is not permitted because when the crew clears to a safe position above the turn, that position will be amongst felled timber, where they are exposed to an unacceptable risk of moving or rolling logs.

- Straight uphill yarding, in steep, runaway-prone ground is extremely hazardous and is only permitted when no other possible rig-up is available, and then only when the following procedure is followed:

  1. Workers clear the turn and any potential runaway areas *before* signalling to "go ahead."
  2. Yarding and loading activity is then permitted while the turn is in motion and being landed and while the rigging is skinned back out.
  3. Workers *stay in this safe position* until the rigging is "spotted."
  4. After the stop whistle is blown and workers are walking into, setting and clearing the turn, *all landing activity that has even the remotest possibility of dislodging material or logs is prohibited.*
  5. Workers clear to a safe area as in (1), signal to "go ahead," and the cycle of yarding and landing activity starts again.
  6. If the landing crew cannot keep up, the rigging can be "hung up" on the landing until they catch up.

  This procedure will ensure that chunks or logs are not dislodged to slide downhill onto the crew while chokers are being set. Workers must also follow this procedure when working close to the landing, without sufficient distance from landing and loading activities, to the advantage of the cross-slope.

- Uphill yarding must only be considered temporary and not used as a general practice because:
  - the rigging crew usually has to walk an excessive distance to a safe position, and fatigue and production pressures will surely cause risk-taking
  - workers will still be exposed if there is any mistake, breakdown in process or "naturally occurring" or delayed runaways while the crew is entering, setting or leaving the turn.
- When the rigging is coming back, the rigging crew must be:
  - at least 1.5 choker-lengths away from the rigging
  - alert for and clear of any material that could be caught up by and carried back by the rigging, carriage or chokers.
- If a dropline system is used, the dropline must not be lowered while the carriage is returning because the dropline or rigging can hang up and swing to reach workers.
- When choosing a safe location, workers must allow for the swing and cast capability.



Uphill yarding on steep slopes with workers in safe position.

Safety Check List for Helicopter-logging Methods

Project Management

- The logging supervisor should ensure that:
  - ~ flight paths during logging will not affect travelled roads; active roads may be closed off, either with flagmen or gates
  - ~ radio frequencies between air and ground crews are coordinated
  - ~ workers hold daily meetings prior to starting the shift to discuss safe operation for the day
  - ~ locations of workers are regularly communicated to the first-aid attendant and the pilot of the support aircraft
  - ~ all workers receive proper job safety training
  - ~ all work activities adhere to recommendations in the WCB handbook *Helicopter Operations in the Forest Industry*
  - ~ all trees within reach of the work area are assessed for hazard as per the procedures described earlier in Section One , under *Inspection of Remaining Stand.*
- The heli-logging company is responsible for ensuring that all safety requirements of heli-logging are met and that the workers will not be exposed to any undue risk.
- All project personnel should be provided with a map which shows log landings, sorting and loading areas, choker and support helicopter landings, refuelling locations, emergency evacuation landing, etc.

Layout

Helicopter logging is most suited for group retention cutting patterns (e.g., corridors and patch cuts) where the work area is free of standing trees and workers "in-the-open" are least exposed to dangers associated with rotor wash.

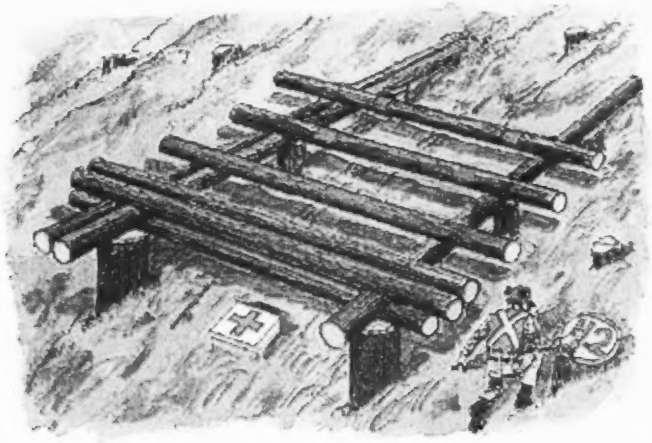
Although dispersed retention cutting patterns are possible (e.g., the uniform distribution of leave-trees across the cutblock) they greatly increase the size of the work area, complicate the rigorous hazard assessment procedure that must be applied in standing timber and increase worker exposure to the overhead hazards of rotor wash.

Drop Zones

- The logging supervisor should ensure that:
  - ~ flight paths into/from the drop zones are clear of crews and support aircraft
  - ~ all perimeter trees which could be blown or knocked over onto the landing area are felled before activities start
  - ~ boom boats are out of the way when water drops are being used
  - ~ landings are large enough to accommodate all planned work activities
  - ~ "head" chasers are designated to supervise landing activities.

Helipads

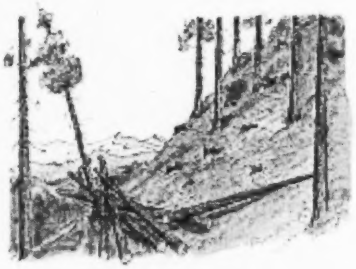
- The logging supervisor will ensure that:
  - helipads are properly designed and constructed for the intended machine
  - helipads are located within 20 minutes walking distance of work areas
  - saplings, trees and debris are moved two helicopter lengths (from outer edge of main rotor to outer edge of tail rotor) from the helipad
  - helipads are numbered and marked, and their locations clearly marked on logging maps
  - the date of construction and materials used in helipads is recorded and noted on the map
  - an emergency shelter and supplies are kept on sites where there is poor access and for evacuation purposes
  - a work shutdown policy for fog, wind, rain and mechanical problems is established and followed
  - helipads are regularly inspected by a qualified or experienced person during heli-logging operations
  - damaged or hazardous pads are repaired or dismantled promptly.



Clearly identify usable helipads.

Felling and Bucking

- When felling, fallers will:
  - ~ leave marked retention trees only if normal safe work procedures will not be compromised
  - ~ fell small trees on rock bluffs which could otherwise be blown down onto workers.
- When bucking, fallers will:
  - ~ buck or split logs to safe lifting weight for the size of helicopter
  - ~ ensure that all cuts are complete or, if unsafe to complete buck, clearly mark and notify supervisor
  - ~ not chase runaway trees in steep ground
  - ~ not buck below felled or bucked timber if deemed unstable (buck later and reposition if necessary).



This leave-tree should have been substituted with another tree by the faller to avoid creating dangerous conditions for the rigging crew. Remove such trees before flying the wood or tag a safe distance away.

- Excessively steep ground where logs cannot be held for safe bucking should be excluded from the cutblock.

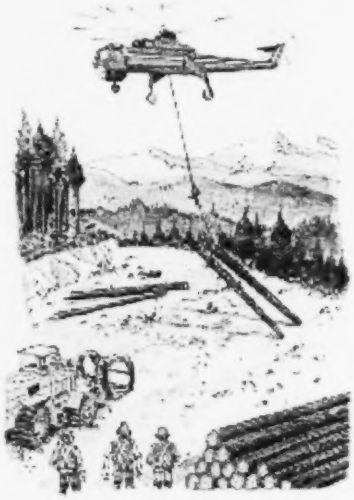
Turn Procedures

- The hooktender/pilot will select a turn that:
  - ~ is free of overhead hazards
  - ~ does not brush leave-trees.
- The hooktender will ensure that choker sizes are appropriate for the logs being harvested and that chokers are in good condition.
- The hooktender will ensure that workers remain in the clear until the turn is gone, dislodged material has stopped moving, and there is no hazard from a broken choker or hung-up log.
  - ~ "In the clear" is:
    - preferably upslope and 90° away from the flight path
    - out of the bight area of the logs, long line and aircraft position
    - at least one log length away from closest hooked log end
    - not below any loose material
    - away from trees and saplings damaged or leaning due to logging activity
    - outside the no-work zone of any wildlife/danger tree, wildlife tree patch or riparian management areas.
- Pilots and hooktenders must not operate beneath rock bluffs with loose debris and/or small trees which may be blown down onto workers.

Ensure a clear flight path is available.

Landings

- The logging supervisor will ensure that:
  - ~ choker retrieval, log decking and loading activities are coordinated
  - ~ the loader is positioned in such a way that it is not in the lead with incoming logs or aircraft
  - ~ all trees that could be struck and knocked into the landing are removed
  - ~ a "head" chaser is designated to supervise landing activities.



Keep the flight path clear of crews, support aircraft and boom boats.

Rotor Wash

Helicopter logging in partial cuttings can be extremely hazardous, mainly due to the effects of rotor wash. The wind velocity associated with helicopter rotor wash may blow trees down, dislodge hazards in trees, or fling debris around, making rotor wash very dangerous to workers. Therefore, safety procedures for helicopter logging operations must be more rigorous than those employed for other logging methods.

Minimize exposure to the hazards of rotor wash.

- The logging supervisor must ensure that all standing dead trees that can reach or endanger fallers/logging crews are removed, regardless of lean, because rotor wash can:
  - ~ cause trees to fall against their lean
  - ~ dislodge bark and limbs
  - ~ cause trees that are blown over or damaged along the upper boundaries of a steep setting to slide or roll downhill.

  Rotor wash can also:
  - ~ blow the tops off trees, particularly in hemlock/balsam stands
  - ~ dislodge school marms and suckers
  - ~ cause loose chunks and tops from the felling phase to be blown downhill
  - ~ blow over trees and saplings
  - ~ blow small trees off rock bluffs.

Hazard Assessment

Supervisors will ensure that:

- all designated leave-trees within the operational area have been assessed for stability and overhead hazard prior to felling, and that all danger trees are removed;
- a competent individual inspects all areas to ensure that all hazards (e.g., danger trees; damaged, hung-up or brushed trees damaged during felling; widowmakers; loose bark; small trees on bluffs) are identified and removed before logging;
- a safety inspection flight is performed before logging to confirm the removal of any hazards created during felling;
- the work area is thoroughly inspected for windthrow hazards after significant storm events, especially after weekend storms.

Refer to procedures outlined earlier, in Section One under *Inspection of Remaining Stand*.

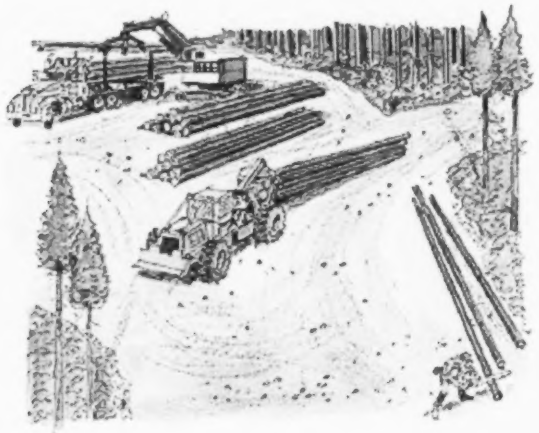
Always perform a safety inspection flight prior to logging to ensure all hazards are removed.

Safety Check List for Ground-based Logging Methods

Landings

- Workers must not work in the immediate loading area and must obtain the attention and "come ahead" approval of the loader operator before entering the loading area and/or passing by the truck or loader.
- Logging supervisors will ensure that landings are large enough:
  - for specific equipment combinations and harvest methods
  - to allow for safe log processing if whole-tree harvesting is to be employed.
- If a landing is small, logging supervisors should consider:
  - sorting elsewhere (possibly the mill yard)
  - limiting the number of skidders
  - using line or hydraulic loaders, since they need less space and allow for roadside loading
  - bucking and limbing or processing in the bush, to ensure that slash and logging debris will not clutter the landing.
- Logging supervisors should:
  - check the stability of log decks, particularly short wood decks
  - schedule trucks carefully to minimize the need for large deck size and to keep decks at a safe height.

Any tree that will interfere with safe landing activity must be removed.



A well-organized landing of sufficient size is essential to safe operations.

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Skidding/Forwarding Trails

- Logging supervisors should ensure that:
  - trails have been clear-felled and danger trees removed before skidding commences
  - trails are of the appropriate width to minimize skidding damage to roots and residual stems
  - there are no tight or unnecessary turns, and access is angled into the landing or roadside, or junctions widened to minimize swing
  - selected rub trees are firm enough to resist being pulled over by logs being skidded past (consider topping if necessary to improve stability)
  - where tight turns cannot be avoided (due to uneven terrain or partial-cut requirements), options such as short- or medium-wood systems, or more gentle curves can be considered to minimize the sweep of the turn and the brushing/rubbing of standing timber
  - intersections of more than two trails are avoided
  - branch trails are angled 35° or less to the felling pattern (herringbone) or to the main trails to minimize the sweep of the turn and the possibility of brushing/rubbing of standing timber

Consider using protective devices to improve durability of rub trees.

  - the maximum grade of the skid trail conforms to the safe operating range of the skidding equipment being used
  - trails are spaced as widely as possible, taking into account the maximum reach of the feller buncher/hoe (e.g., crane zone) and any manual felling to occur between crane zones
  - the skid trail system accesses all areas of the logging project, so as to not put the skidder in a compromised winching position
  - the skid trail system utilizes favourable grades and natural topographic features to facilitate skidding and minimize soil disturbance
  - there is no cross-slope skidding on steep terrain, unless excavated skid trails are built to obtain a flat running surface to help control the rollover hazard and turns swinging downhill and damaging leave-trees
  - to minimize trail wear and the likelihood of turns swinging downhill on side-slope trails, the top side of trails should be skidded first, and then the lower side from back to front
  - steep trails have adequate and designated turnarounds.

An efficient trail network is essential to safe operations.

Felling

Mechanical felling

When using feller bunchers, stubs can safely be left for wildlife habitat.

- The logging supervisor should ensure that:
  - safety procedures for tree processors and feller bunchers working with hand fellers are followed
  - buncher size is matched to the size of timber being felled
  - a buncher with sufficient reach is used to fell trees within the crane zone and reach any trees manually felled between crane zones
  - operators know the capacity of their equipment, operate within the specified grade maximums of the equipment, and do not attempt to cut oversized timber
  - all oversized timber is left for the hand fellers, and not brushed up by the buncher
  - bunchers are placed at an advantageous angle close to the skid trail to facilitate skidding, minimize hang-ups, and reduce the distance that skidders have to back around leave-trees.
- Logging supervisors must establish slope limitations for the equipment combinations being used, and plan the operations accordingly.
- Where stub creation is specified, the logging supervisor must choose a stub height that allows for the safe cutting and handling of each tree. Selected stems should have some defect (e.g., scar, split trunk, conks) in the lower bole which would make them suitable as future wildlife trees.

Hand felling

- Fallers must identify all overhead hazards, hung-up trees and branches, and control the hazards. Hung-up trees must be pushed down/removed immediately or a safe no-work zone established.
- Fallers must remove danger trees within standing timber as soon as it is safe to do so.
- Fallers should take extra care when felling oversized trees (left by mechanical felling machines), especially if the amount of holding wood has been compromised by an unsuccessful mechanical felling attempt.
- A suitable mancheck system for fallers must be employed when felling oversized trees, since the spacing of oversized trees makes for rapidly changing felling locations. This requires effective communication between the faller and other workers.
- Fallers must fell trees at an advantageous angle to the skid trail to facilitate skidding and minimize hang-ups.
- When manual felling is employed between crane zones, trees should be felled towards and into the crane zone so that bucked logs are retrievable by the feller buncher/hoe-forwarder.

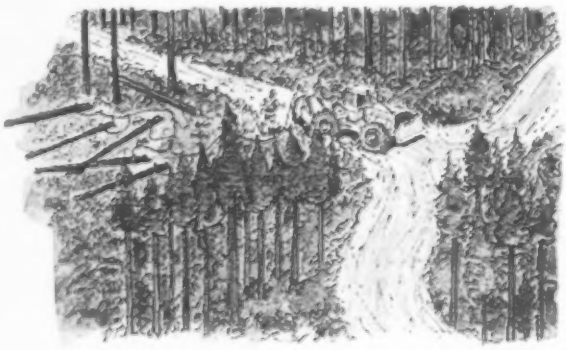
Always remove danger trees that can impact the work area.

Skidding

Poorly set turns will hang up on leave trees.

- Skidder operators will inspect mainlines and chokers frequently, and replace them when necessary.
- Skidder operators should maximize the use of winches to avoid backing around and causing damage to leave-trees.
- Skidder operators will set the turn in such a way that logs will pull into lead without hanging up on leave-trees.
- When hang-ups occur, the machine operator will inspect the problem, re-set chokers and re-position the machine, if necessary, to dislodge hang-ups.
- If unable to dislodge hang-ups, the machine operator should get a faller to buck the hung-up log or fell timber preventing the hang-up from being dislodged.
- Machine operators will ensure that the weight of the turn does not exceed the safe operating limits of the machine.
- In partial cutting, machine operators and swampers must use the WCB-specified hand signals and voice commands.
- When more than one skidder is using the same trail and landing, machine operators must establish and adhere to a traffic plan.
- Logging supervisors must confirm that:
  - ~ rub trees are large and firm enough to resist being pulled over by passing equipment and turns
  - ~ standing dead trees are not used as rub trees

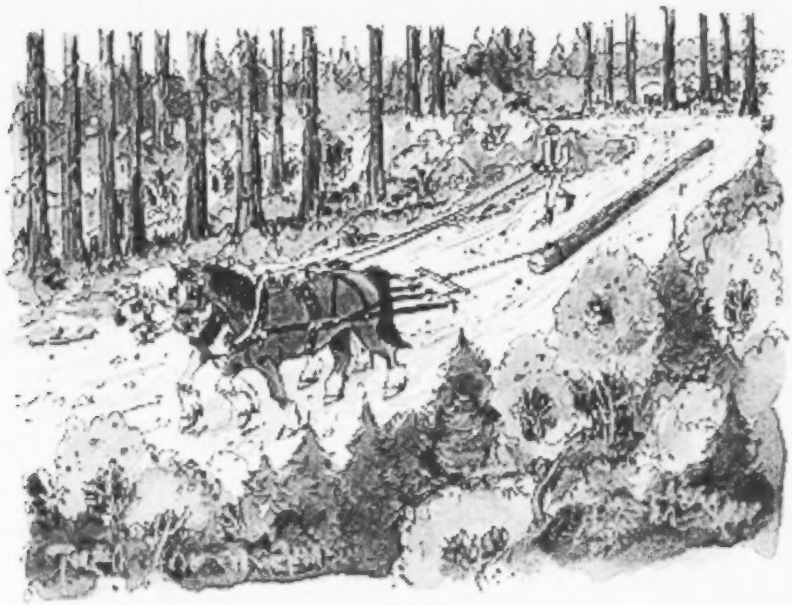
  and ensure that:
  - ~ rub trees are felled last, from the back of the project to the front, after skidding from side trails or a herringbone pattern is complete
  - ~ rub trees made unstable as a result of skidding operations are removed immediately.



Utilize favourable grades and natural topographic features in locating skid trails to efficiently access the cutblock, facilitate skidding and minimize site disturbance.

Safety Check List for Horse-Logging Methods

While horse logging can be an effective way to skid logs, it can also be hazardous. The guidelines provided below are designed to ensure that anyone involved with horse logging operates in a safe and successful manner.



Horse logging requires a high degree of awareness.

Training and Preparation

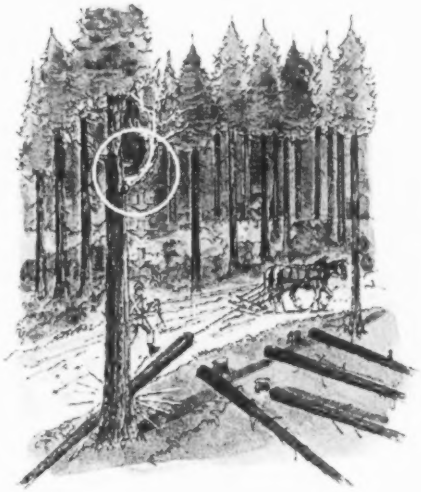
- Before beginning horse logging, the faller/teamster should obtain extensive training from an experienced and well-qualified horse logger or horse logging instructor.
- When a faller and teamster are working together, regular checks should be made to ensure the safety of each worker.
- Before beginning work, the faller and teamster should walk the area to be logged and become familiar with:
  - felling boundaries
  - reserve patches
  - actual or potential hazards or problem areas
  - locations of landings and skid trails.
- All workers must wear adequate eye, face and hand protection.

Horses and Their Equipment

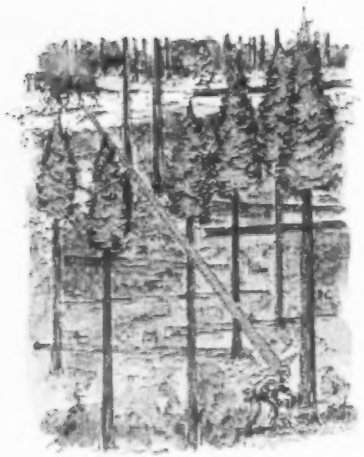
- Teamsters should always work to improve their understanding of how individual horse(s) will react to the wide variety of situations encountered in horse logging. Teamsters should exercise a great degree of caution in all aspects of the logging operation until a working familiarity is achieved between the teamster and the horse. Horses that work well together and with the teamster are of the utmost importance for safe operations.
- Teamsters should:
  - consider having more than one team or an additional horse, and follow a horse rotation schedule because overexcited or tired horses may cause accidents
  - ensure that equipment is adequate and in good condition; for example:
    - the harness is of proper size and shape to fit the horse comfortably
    - the reins are long enough for the work to be undertaken—the minimum suggested length is 5–7 metres
    - make sure collars and other gear are not age weakened and are properly adjusted.
  - skid only with horses that have been well-broken to ensure they will not spook; desirable attributes are:
    - at least five years old, with exposure to a variety of working conditions under harness
    - trained to pick up their feet on request
    - do not become overly excited by strange noises or sights
  - work to improve their understanding of each horse's temperament and reactions to various situations and stimuli. For example, know how each horse:
    - responds after not having worked for two or more days
    - reacts to a new team member
    - responds when in season or to another horse in season
    - is affected by weather
    - responds to equipment such as chainsaws, crawler tractors, log loaders, trucks, and other loud noises
    - reacts to dogs, bears, wasps, horseflies, etc.
    - reacts to being hit by chainsaw dust or chips.
  - ensure that a humane killing device is available, in case of mortal injury to a horse
  - check horses over carefully on a daily basis for sores on the mouth, shoulders, rump and legs, and cuts on the legs and feet
  - treat cuts immediately; if a horse is painfully injured it must be returned to the barn
  - equip all horses with blinders, particularly in light thinnings, to prevent scratch and puncture injury to the eyes
  - use fly spray, since horses may be sensitive to fly bites or may become annoyed or irritable from bites.

Trails

- Teamsters should:
  - ~ make a good clear skid trail, removing rocks, stumps, saplings, holes or other obstructions that could catch the log and swing it up sideways or stop it
  - ~ remove all stumps, trees and small saplings (with stubs cut flat and close to the ground) on or adjacent to the skid trail that could be rubbed or bent over by the turn being skidded and spring up unexpectedly to strike the horse or the teamster
  - ~ brush trails out and remove dead limbs from bottom two metres of trees on each side of skid trails
  - ~ lay out trails to maintain two tree-lengths between the teamster/horses and the felling area.
  - ~ where possible, locate trails where there are no depressions or rock outcrops that a log can hang up on
  - ~ constantly monitor for overhead hazards and snags which the faller may have missed; if a significant overhead hazard exists, it must be removed or the trail re-routed.



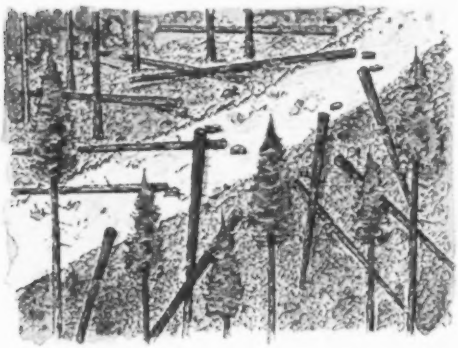
Keep trails clear of overhead hazards.



Always maintain a safe distance of at least two tree-lengths between fallers, horses and other workers.

Felling

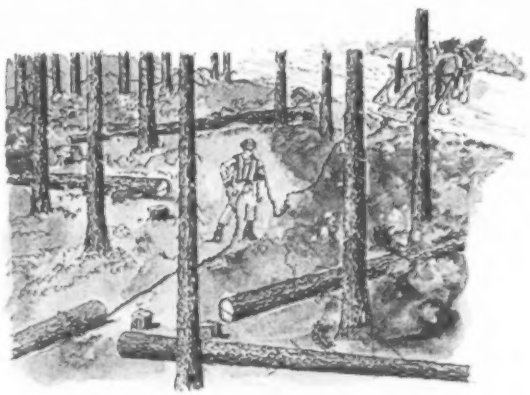
- Fallers must work at least two tree-lengths away from the team—further away if the ground is sloping.
- If possible, the faller should fell trees so they can be skidded butt-first, which is easier and safer for the horses.
- Fallers should fell trees at the most advantageous angle to the skid trail so horses do not get caught up in adjacent trees or obstacles.
- Fallers should ensure that trees are well limbed so friction is reduced and the chances of a limb hitting or tripping the teamster are reduced.
- Fallers must buck trees to lengths and weights that permit safe loading and minimize sweep.



Fell trees in a herringbone pattern to the skid trail to prevent horses hanging up turns on leave-trees.

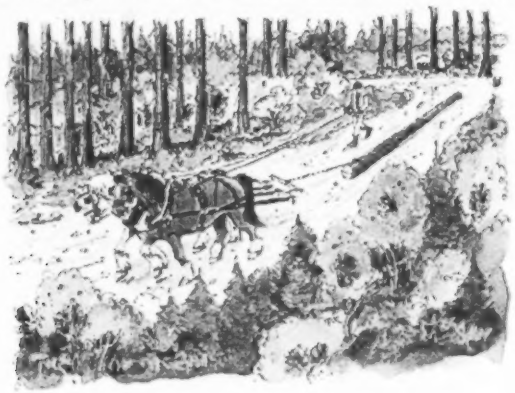
Yarding

- When yarding with horses, the teamster should:
  - pay extra attention to sudden stops or bolting of the horses to avoid being thrown off when using a yarding arch/cart
  - inspect yarding arch/cart daily for weak points or damage
  - select firm trees for block tailholds
  - ensure horses are warmed up before having to pull heavy loads
  - alternate easy drags with heavy drags so horses do not get too tired and difficult to control
  - begin at the back end of the skid trail and work toward the landing to keep debris behind the horse and the teamster
  - trim all stub limbs off the log before skidding
  - prune broken limbs from the base of trail side trees to prevent stabbing injuries
  - leave horses facing the turn while hooking the chain, choker or tongs to turn the logs
  - not hook up the turn to the team until ready to go
  - not use tongs or other self-tensioning devices to hook up a load on steep hills where the load may slide on the way down and come loose from the tongs
  - hook close to the end of short logs to prevent them from flipping end-for-end if they hit an obstacle while being skidded
  - use two or more chains when necessary to pull a log to a better position for closer choking of the log



Use two or more chains if required to pull tree into better position for closer choking of logs.

- hook the skidding chain into the "D" on the whippletree so it will not drag on the ground where it can catch and damage the harness or injure the worker or the horse
- always undo the chain choker from the harness hook when hooking up a log to the horses
- ensure the pathway is clear of debris before starting off with the drag
- ensure that the log is free of hang-ups and will twist free as the drag begins
- start out slow and steady—the first 10 metres is the most dangerous part of the skid



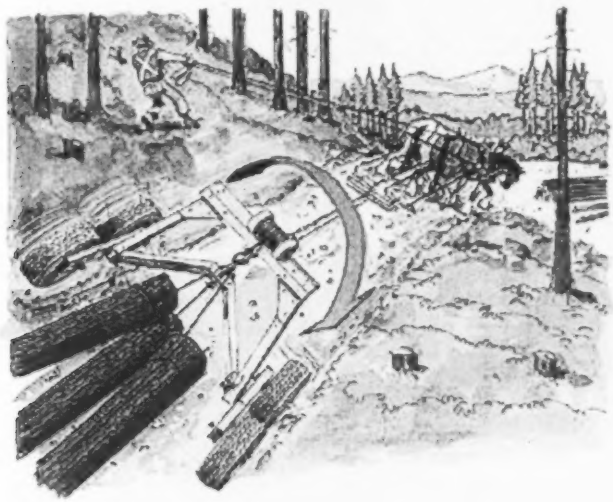
Keep a safe position to the side and uphill of the log being skidded.

- keep horses to a controlled walk when travelling to the bush and especially when skidding the turn out of the bush
- keep a safe position to the side and uphill of the log being skidded
- not walk alongside the horses on slippery or broken ground in case they lose their balance
- never be positioned in front of the log being skidded
- step over rather than on the log being skidded, and stay outside the rigging
- change sides to stay clear of the swing load on turns in the trail because the load may pivot against a standing tree and swing sideways

Watch for pivots and swinging logs.

- if an unsafe situation arises, halt the team and immediately move to a safe position
- alternatively, let go of the reins and wait until the horses have moved past the danger area; then tell them to "whoa" before moving forward to pick up the reins and carry on with the drag
- always unhook the chain from the doubletree before unhooking it from the logs.

- When using a logging arch or cart to skid logs, the teamster should always:
  - avoid operating on slopes where tipping is a hazard
  - hook up to the front of the log and drag it straight ahead to avoid tip-overs
  - be sure the bullboard is high enough to prevent the teamster from falling forward.
  - be aware of the fatigue level of the team; although the teamster may be quite fresh, as the day progresses, the team may become very tired.



Avoid operating on steep side slopes where tipping over is a hazard.

At the Landing

- The teamster should:
  - ensure that all logs are either decked or out of the way on the landing so there is plenty of room for the next turn or logs
  - remove small debris or branches from the landing so horses don't trip or step on them causing them to flip up.

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Appendix 1: Controlling Windthrow

Traditional weather patterns and history of winds must be considered in controlling windthrow. For example, if a clearcut is creating a wind funnel endangering an adjacent riparian management zone, feathering trees in the management zone may decrease windthrow.

Partial-cutting treatments open the canopy and increase the drag force on individual trees: this increases the risk of overturning and is especially likely to happen on high and moderate windthrow-prone sites.

Dominant trees shelter other trees; windfirmness is a function of height, dominance, tree form and root stability. Non-dominant trees may require close appraisal.

If you are working in a canopy of uniform height, windfirmness is a function of shelter, intercrown damping, and root stability. The denser the stand, the more likely it is that the roots on the perimeter have been stressed. Close appraisal of each tree for root damage is advisable.

The amount of canopy removal should reflect the windfirmness of the original stand. Poorly-drained areas, with shallow soils and pockets of root rot are particularly sensitive to wind.

In all stands, one should consider visible forest health concerns such as root rot, fungal fruiting bodies, and beetle or moth infestation.

In order to manage for wind in partial cutting:

- retain sound, well-rooted veterans (e.g., snag-top cedars) or deciduous trees;
- retain sound trees (strong roots and high taper) with relatively small, open crowns;
- retain sound snags where safety is not compromised;
- remove the most vulnerable stems first (e.g., unsound trees, especially those with large crowns; trees with asymmetric or stilt roots; trees growing on unstable substrates such as rocky knolls, boulders, nurse logs, or poorly drained depressions; and tall, non-veteran trees with disproportionately large crowns or any of the previous characteristics);
- ensure that small leave patches are located on deep, well-drained soils or other topographically protected sites where windthrow hazard is low.

> *Logging contractors, supervisors and fallers with experience in the area being considered can provide a wealth of information useful for assessing windthrow risk and developing management strategies.*

The information that follows is drawn from the Riparian Management Area Guidebook, Forest Practices Code of British Columbia (1995).

Windthrow Hazard Management

Riparian management areas in stands of moderate or high windthrow hazard require special management practices to reduce windthrow potential when logging is proposed within and adjacent to them. Where a reserve zone is required, windthrow hazard management should be designed primarily to protect the reserve zone and only secondarily to protect trees within the management zone.

Assessing Windthrow Risk

The Windthrow Handbook for British Columbia Forests (Research Program Working Paper 9401) should be consulted for guidance when assessing windthrow risk or developing prescriptions to reduce the risk of windthrow. Windthrow risk assessments should incorporate local knowledge and experience, and should be assessed for the general area and, in greater detail, for each area with significantly different soil depth or drainage, stand structure, and tree species composition. Windthrow risk assessment should be a best judgement interpretation based on an evaluation of regional, local and site-specific information.

Windthrow risk is determined by the interaction between factors that affect the force of the wind acting on the tree and factors that affect the resistance of the tree to overturning. Force of the wind is increased by higher wind velocity and turbulence, increased exposure to wind, greater tree height-to-diameter ratio, greater crown size and density, and reduced stand density. Resistance to overturning is reduced by poor root anchorage due to saturated soils and restricted rooting depth, the occurrence of root or bole rot, the extent of interlocking root systems, and past exposure to winds. Soil factors that control rooting depth contribute most significantly to windthrow risk.

High risk stands generally occur where high wind force is likely to occur and resistance to overturning is low. Moderate risk stands occur where root anchorage is poor but wind force is low, root anchorage and wind force is moderate, or root anchorage is good but wind force is likely high. Low risk stands occur where there is a high resistance to overturning and wind force is moderate or low.

Windthrow risk is generally greatest on the windward edge of a stand and decreases a short distance into the stand, although turbulence can result in windthrow several tree heights into the stand. Most windthrow occurs within the first three years following harvesting. However, windthrow risk can increase over time as management activities affect windflow and soil conditions.

Local knowledge is an important consideration when assessing windthrow risk. Certain areas are known to be particularly windy. A history of frequent windthrow and evidence of windthrow or stem breakage in natural stands is an indication that windthrow is likely to occur after harvesting.

Windthrow Management Strategies

Strategies to reduce the risk of windthrow should be considered wherever trees are retained and windthrow risk is moderate or high along all or a portion of the riparian management area (RMA). Windthrow management strategies include locating the tree retention boundary to reduce the risk of windthrow, selecting the most windthrow resistant trees within the management zone for retention, and reducing the force of the wind on the crowns of retained trees. Selected strategies should not only address windthrow risk but also the other values that are being protected in the RMA.

Options to Reduce Windthrow Risk to the Reserve Zone

Where windthrow risk is moderate or high in the reserve zone, a sufficient number of trees should be retained within the management zone to protect the windfirmness of the reserve zone. Options include location and design of logging boundaries and edge stabilization treatments.

Location and Design of Logging Boundaries

- Realign the RMA or block boundary to a windfirm edge, such as rock bluffs, non-merchantable timber, bogs, landslides or snow avalanche tracks.
- Leave a buffer at least 20 m wide of well-drained, deep soils between areas of poorly drained or shallow soils of the RMA and the edge of the harvested opening.
- Avoid locating boundaries in areas that show evidence of previous or chronic windthrow.
- Where no natural windfirm features are available, consider widening the management zone to a moderate to low windthrow risk stand and align the boundary so that it is at an angle or parallel to the prevailing storm winds.
- Leave relatively straight boundaries on the outer edge of the RMA. This can be accomplished adjacent to meandering streams by leaving variable width patches of trees in the management zone. Do not leave any sharp corners or indentations that are exposed to the wind.

> *Where a riparian management zone is more prone to windthrow than the reserve zone, and blowdown of residual trees is inevitable, low tree retention of only the most windfirm trees in the management zone may be the best windthrow management option.*

Edge Stabilization Treatments

- Feather the outer edge of the management zone by removing trees prone to windthrow; preference should be given to removing: unsound trees including diseased, deformed, forked, scarred, mistletoe infested, and root rot infested trees; trees with asymmetric or stilt roots; trees growing on unstable substrates such as rocky knolls, large boulders, nurse logs, or wet depressions; tall non-veteran trees, especially those with disproportionately large crowns.

- Preference for retention should be given to sound, well-rooted veterans (e.g., snag-top cedars) or deciduous trees; sound trees (strong roots and good taper) with relatively small, open crowns; and sound snags when safety is not compromised.
- In multi-storied stands, the outer wind-exposed edge of the management zone may be additionally feathered by removing dominant trees from the leading edge, partially retaining co-dominant trees, and fully retaining suppressed trees within 20–30 m of the edge. This practice is not recommended in single-storied, high density stands.
- Top, prune (limb) and/or crown thin individual trees with a high windthrow risk in the management zone and/or reserve zone; reduce the crown of these trees by 20–30 per cent; topping or pruning in the reserve zones should include only high windthrow risk trees that may cause significant detrimental effects to stream channels or wildlife habitat if they were windthrown.
- combine edge feathering and topping, pruning, and/or crown thinning in high hazard areas.

Options to Reduce Windthrow Risk in the Management Zone

Options to reduce the risk of windthrow to trees retained in the management zone include crown-thinning, pruning and topping, and/or selection of the most windfirm trees for retention. Trees with the following characteristics tend to be the most windfirm:

- short trees and trees with small open crowns, all else being equal;
- trees that have been growing in relatively open stand conditions;
- low height-to-diameter ratio for the stand (e.g., relatively large taper);
- sound, well-rooted veteran trees;
- sound snags;
- good root anchorage in deep, well-drained soils;
- no root or bole rot;
- specific conifer species (dependent on form and rooting habit);
- broad-leafed deciduous species, provided they are not over-mature.

Removal of Windthrown Trees

When windthrow occurs within an RMA, the remaining standing trees should be left as a protective buffer for the other trees. Windthrown trees should not be removed from the RMA as they provide valuable wildlife habitat. Windthrown trees should be removed only if habitat would be improved by their removal, and if removal would not result in damage to the surviving trees. Windthrown trees should be assessed for removal by a forest health specialist where there is a risk of increasing bark beetle populations. Windthrown trees that have entered a stream should be removed only if they will destabilize the streambank or channel. Unnecessary removal of windthrown trees from streams can result in significant channel destabilization. Any removal of windthrown trees from an RMA must be specified in an approved silviculture prescription.